

MAY 1957



VOL. 49 • NO. 5

# Journal

## AMERICAN WATER WORKS ASSOCIATION

---

*In this issue:*

**DISPOSAL OF RADIOACTIVE WASTES**

Wolman

**UNIFORMITY OF FLUORIDE ION LEVELS**

Taylor

**NETWORK ANALYSIS BY DIGITAL COMPUTER**

Hoag, Weinberg

**SAN DIEGO COUNTY DEMANDS**

Beermann, Holmgren

**CONVERSION OF IRRIGATION SYSTEMS**

Burzell

**GROWTH OF IRRIGATION IN ILLINOIS**

Black

**EXPERIENCE WITH MICROSTRAINER UNITS**

Evans, Taylor

**1955 WATER WORKS OPERATING DATA**

Staff Report



*Lots of intake  
but little take-in  
at San Diego's  
droughtbound  
El Capitan Reservoir*

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**First Choice for  
Extreme Reliability**

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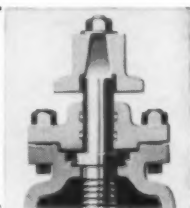


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# Journal

AMERICAN WATER WORKS ASSOCIATION

2 PARK AVE., NEW YORK 16, N.Y.

Phone: MUrray NHl 4-6686

May 1957

Vol. 49 • No. 5

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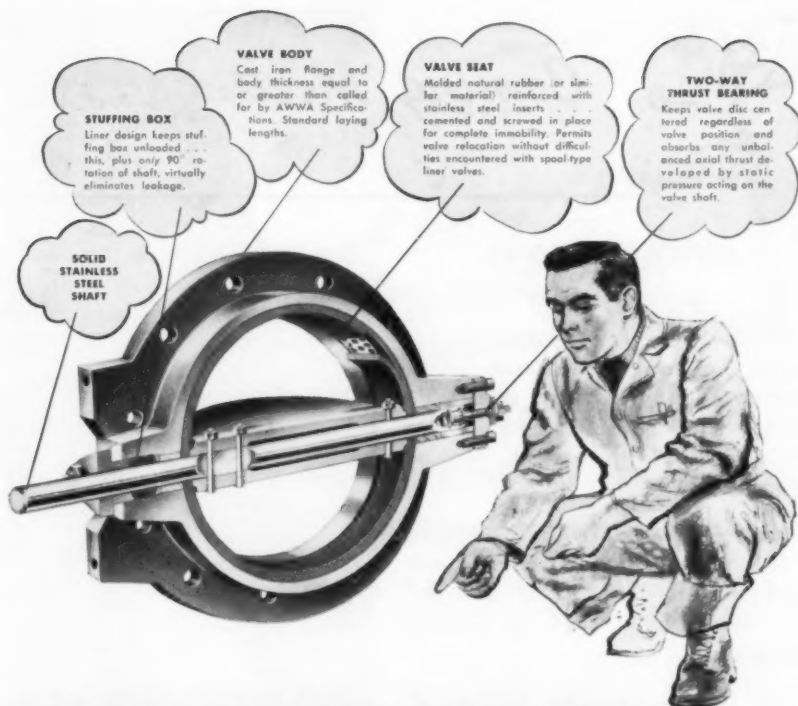
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## Coming Meetings

### AWWA SECTIONS

#### Spring Meetings

**Jun. 6**—New Jersey Section Spring Outing & Luncheon, at Canoe Brook Country Club. Secretary, Albert F. Pleibel, Dist. Sales Manager, R. D. Wood Co., 683 Prospect St., Maplewood.

**Jun. 12-14**—Pennsylvania Section, at Bedford Springs Hotel, Bedford Springs. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg.

**Jun. 17-19**—Canadian Section, at Royal Alexandra Hotel, Winnipeg, Man. Secretary, A. E. Berry, Director, San. Eng. Div., Ontario Dept. of Health, 72 Grenville St., Toronto, Ont.

#### Fall Meetings

**Sep. 4-6**—Wisconsin Section, at Hotel Schroeder, Milwaukee. Secretary, Harry Breimeister, Chief Utility Engr., City Engineer's Office, City Hall, Milwaukee 2.

**Sep. 11-13**—New York Section, at Saranac Inn, Upper Saranac Lake. Secretary, Kimball Blanchard, New York Branch Mgr., Rensselaer Valve Co., c/o Ludlow Valve Co., 11 W. 42nd St., New York.

**Sep. 18-20**—Ohio Section, at Netherland Plaza Hotel, Cincinnati. Secretary, M. E. Druley, Dist. Mgr., Dayton Power & Light Co., Wilmington.

**Sep. 23-25**—Kentucky-Tennessee Section, at Brown Hotel, Louisville, Ky. Secretary, J. Wiley Finney Jr., Howard K. Bell, Cons. Engrs., 553 S. Limestone St., Lexington, Ky.

**Sep. 24-25**—Rocky Mountain Section, at La Fonda Hotel, Santa Fe, N.M. Secretary, J. W. Davis, 301 Continental Oil Bldg., Denver 2, Colo.

**Sep. 25-27**—Michigan Section, at Leland Hotel, Detroit. Secretary, T. L. Vander Velde, Chief, Sec. of Water Supply, State Dept. of Health, Lansing 4.

**Sep. 25-27**—North Central Section, at Gardner Hotel, Fargo, N.D. Secretary, L. N. Thompson, 216 Court House Bldg., St. Paul 2, Minn.

**Sep. 29-Oct. 1**—Missouri Section, at Sheraton-Jefferson Hotel, St. Louis. Secretary, W. A. Kramer, State Office Bldg., Jefferson City.

**Oct. 13-16**—Southwest Section, at Skirvin Hotel, Oklahoma City, Okla. Secretary, Leslie A. Jackson, Mgr.-Engr., Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

(Continued on page 8)



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**WITH THE RING-TITE COUPLING**

**Coming Meetings**

(Continued from page 6)

**Oct. 16-18**—Iowa Section, at Fort Des Moines Hotel, Des Moines. Secretary, J. J. Hail, Supt., Water Dept., City Hall, Dubuque.

**Oct. 20-23**—Alabama-Mississippi Section, at Buena Vista Hotel, Biloxi, Miss. Secretary, C. M. Mathews, Public Service Com., 119 W. Commercial St., Yazoo City, Miss.

**Oct. 23-24**—West Virginia Section, at McClure Hotel, Wheeling. Secretary, H. W. Hetzer, Engr., West Virginia Water Service Co., Box 1906, Charleston 27.

**Oct. 24-26**—New Jersey Section, at Hotel Madison, Atlantic City. Secretary, A. F. Pleibel, Dist. Sales Manager, R. D. Wood Co., 683 Prospect St., Maplewood.

**Oct. 30-Nov. 1**—Chesapeake Section, at Sheraton-Park Hotel, Washington, D.C. Secretary, C. J. Lauter, 6955-33rd St., N.W., Washington, D.C.

**Oct. 30-Nov. 1**—California Section, at Hotel St. Claire, San Jose. Secretary, Henry J. Ongerth, Sr. San. Engr., Bureau of San. Eng., 2151 Berkeley Way, Berkeley.

**Nov. 6-8**—Virginia Section, at Hotel Roanoke, Roanoke. Secretary, J. P. Kavanagh, Dist. Mgr., Wallace & Tiernan Inc., 213 Carlton Terrace Bldg., Roanoke.

**Nov. 10-13**—Florida Section, at Roosevelt Hotel, Jacksonville. Secretary, J. D. Roth, P.O. Bin "O," Miami Beach 39.

**Nov. 11-13**—North Carolina Section, at Hotel Sir Walter, Raleigh. Secretary, W. E. Long Jr., State Stream Sanitation Com., Raleigh.

**OTHER ORGANIZATIONS**

**May 13-15**—Industrial Waste Conference, Purdue Memorial Union Bldg., Purdue Univ., Lafayette, Ind.

**May 20-22**—Northeast Region Spring Conference (NACE) on Corrosion Control by Choice of Materials, Syracuse, N.Y. Write: O. R. Broberg, Lamson Corp., Syracuse, N.Y.

**Jun. 2-6**—Municipal Finance Officers Assn., at Hotel Lowry, St. Paul, Minn.

**Jun. 16-21**—American Society for Testing Materials, Atlantic City, N.J.

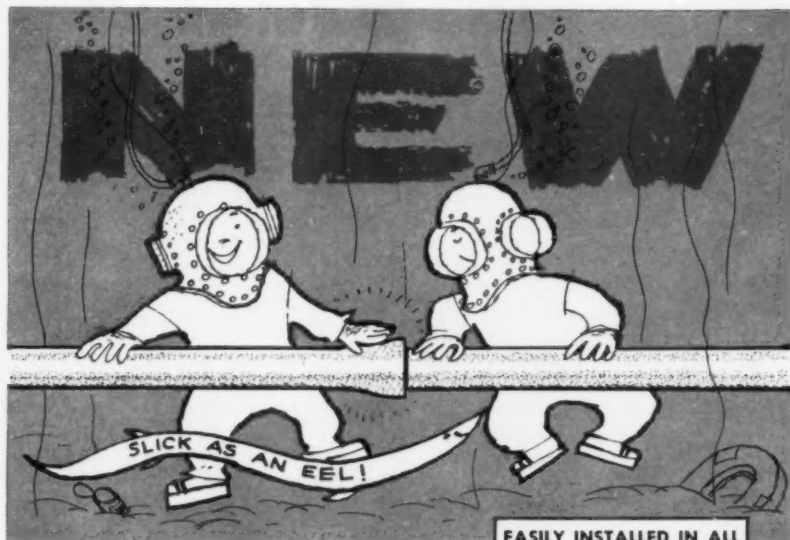
**Aug. 5-9**—Gordon Research Conference on Ion Exchange, at Kimball Union Academy, Meriden, N.H. Write: W. G. Parks, Director, Dept. of Chemistry, Univ. of Rhode Island, Kingston, R.I.

**Aug. 19-23**—North Carolina Water Works Operators School, at Duke Univ., Durham, N.C.

**Oct. 6-9**—Annual Conference & Products Exhibit, National Institute of Governmental Purchasing, at Netherland Hilton Hotel, Cincinnati, Ohio. Write: Albert H. Hall, Exec. Vice-Pres., 1001 Connecticut Ave., N.W., Washington 6, D.C.

**Oct. 7-10**—Federation of Sewage & Industrial Wastes Assns., at Statler Hotel, Boston, Mass.

**Nov. 2-8**—World Metallurgical Congress, sponsored by American Society for Metals, at Chicago, Ill.



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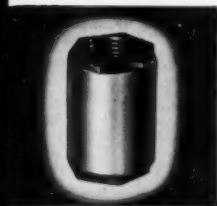
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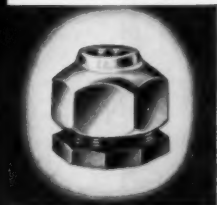
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I.P. to I.P., double bushing

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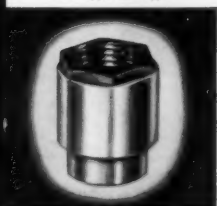
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YOU'RE AHEAD WITH AMERICAN SANITARY

## Hartford boosts its water supply with 6 miles of **CONCRETE PIPE**

During the summer months when water demands were greatest, the higher sections of the Hartford County Metropolitan District experienced low pressure troubles. The problem was solved by the construction of a 54-in. reinforced concrete pipe water line—the largest yet used in the district. This 6-mile project runs from the clear water basins at the West Hartford Filter Plant to a point near the Cedar Mountain Reservoir in Hartford.

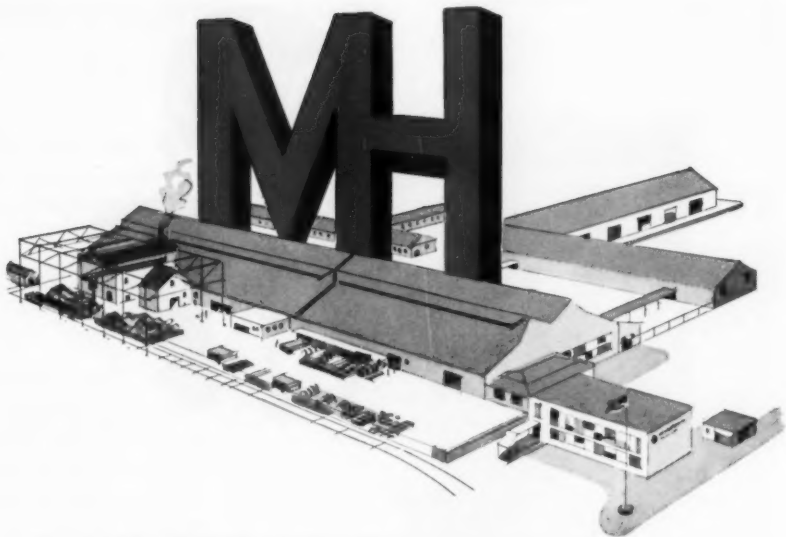
Concrete pipe water lines offer many advantages — moderate first cost, little or no maintenance cost, long life and true **low-annual-cost** service.

### **PORTLAND CEMENT ASSOCIATION**

33 West Grand Avenue, Chicago 10, Illinois

A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work





## **SERVICE is the basis of GROWTH**

"Service" always has been a watchword in the M & H organization — service to the customer.

M & H service begins in the versatile M & H engineering department, with research and design of M & H valves, hydrants and other products. Then follows service by trained manufacturing personnel — craftsmen using highest quality materials. Add a modern, well equipped manufacturing plant, an efficient cost control system and wide-awake sales and shipping departments and you have a composite factor of service which means fulfillment of delivery schedules with superior quality M & H products.

Because service means growth, M & H has become one of the leading valve and hydrant manufacturers of the United States.

**M & H VALVE**  
**AND FITTINGS COMPANY**  
ANNISTON, ALABAMA





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*A Salute to the*  
**WATERWORKS SUPERINTENDENTS**  
*of American Communities*

---

No office in a municipal government is more important to public welfare and safety than that of the Waterworks Superintendent. He is responsible for the lives and property of the entire citizenry. On his shoulders rests the responsibility of seeing that an adequate water supply and service is maintained to protect the public health, furnish fire protection, and meet the rapidly growing water demands of industrial and individual consumers. He is an active factor in helping his community grow from a town to a prosperous and healthy city. His salary should be commensurate with the vital service he performs.

An overwhelming majority of experienced and capable Waterworks Superintendents and Consulting Engineers recommend—

***Permanent CAST IRON PIPE***

when their communities are planning new or enlarged waterworks or sewage system. They know that Cast Iron Pipe has an unmatched record of long life with minimum maintenance cost and maximum saving to taxpayers.

**WOODWARD IRON COMPANY**  
WOODWARD, ALABAMA



Our Company does not manufacture pipe, but has long supplied the nation's leading pipe manufacturers with quality iron from which quality cast iron pipe is made.

**WORTHINGTON-GAMON****WATCH DOG**

The meter used by  
thousands of munic-  
ipalities in the U. S.

**WATER METERS**

"Watch Dog" models  
... made in standard  
capacities from 20 g.p.m.  
up; frost-proof and split  
case in household sizes.  
Disc, turbine, or com-  
pound type.

**SURE TO MEET  
YOUR SPECIFICA-  
TIONS FOR ACCU-  
RACY, LOW MAIN-  
TENANCE, LONG  
LIFE.**



Before you invest in water meters,  
get acquainted with the design and  
performance advantages which  
make Worthington-Gamon Watch

Dog Water Meters first choice of  
so many municipalities and private  
water companies in the United  
States.

**WORTHINGTON-GAMON  
METER DIVISION**

*Worthington Corporation*

**296 SOUTH STREET, NEWARK 5, NEW JERSEY**



OFFICES IN ALL PRINCIPAL CITIES

# MUELLER directory

## *of water works distribution and service products*

**M**ueller offers the most complete line of water distribution and service products — a line backed by a century of manufacturing experience and produced under a rigid standard of quality in workmanship and materials. You are assured of years of dependable service. Standardize on the Mueller line!

### MUELLER PRODUCTS

...Dependable since 1857—for a century, Mueller Co. has been serving the progress of the water industry. Many new products, introduced during this first 100 years, have become the standard of the industry.

**Clip These Pages** as a handy reference.

Sections referred to will be found in Mueller Water Works Catalog W-96. If you have mislaid your copy, or have need for another, contact your Mueller Representative or write direct.



#### Drilling Machines

For cuts  $\frac{1}{4}$ " through 12" under low or high pressure... Simple operation of machine keeps drilling operation under control at all times. (See Section 1).



#### Power Units

Air motor or gasoline engine drive unit may be used with the Mueller "C-1" or "DH-2" Drilling Machine for fast drilling operations. (See Section 1).



#### Tapping Machines

Drill and tap holes  $\frac{1}{4}$ " through 4"... Insert corporation stops  $\frac{1}{4}$ " through 2" or pipe plugs  $\frac{1}{4}$ " through 4" under pressure. (See section 1).



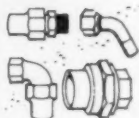
#### Corporation Stops

Mueller, Iron Pipe, Hall or Wood Main Inlets... For thin-wall or small diameter pipe... For Copper service pipe... With lead flange or wiped joint... (See section 2).



#### Lead Goosenecks

Single in wiped joint, lead flange and solder joint types... Two, three, four, six and eight branch in wiped joint or lead flange types. (See Section 3).



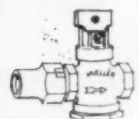
#### Service fittings

Copper Service Pipe... Service pipe fittings and tees... Branch connections... Corporation stop couplings... Lead flange fittings... Solder nipples and plugs... (See section 4).



#### Service Clamps

Single or double strap types with neoprene or lead gaskets... Mueller or I.P. Thread. (See Section 5).



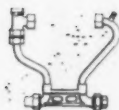
#### Curb Stops

Inverted key—copper service pipe or I.P. threads. Solid tee head—copper service pipe or I.P. threads. "H" pattern—copper service pipe or I.P. threads. Newport Pattern—I.P. threads. Lead flange or wiped joint. (See section 6).



### Curb Boxes

Mueller extension type, arch pattern with optional footpiece or Minneapolis pattern... screw type with 2 1/4" or 3" shaft, enlarged or bell bottom base for curb stops or wheel handle valves... Extensions and repair lids. (See Section 7).



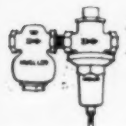
### Meter Setting Equipment

Copper meter yokes...  
Iron meter yokes...  
Meter relocators...  
Water meter couplings...  
Meter box covers...  
(See section 8).



### Rough Plumbing

Ground key stops with or without drain...  
Compression stops with or without drain...  
Sediment and lawn faucets... Bronze gate valves... Ground key stops, angle pattern, with or without drain. (See Section 9).



### Regulators and Strainers

For water, air, oil, gas or steam installations...  
Pressure relief and check valves...  
Temperature relief valves and relief elbows...  
Large diaphragm relief valves. (See Section 10).



### Tools

Pipe jointers, calking sets, yarning irons, hammers, chisels, flanging tools, copper service pipe tools, lead pipe flanging tools. (See Section 11).



### Fire Hydrants

AWWA Improved, in 4 1/4", 4 3/4", 5 1/4" and 6 1/4" sizes... Standard and flush types in 4 1/4" and 5 1/4" sizes... Standard and flush types in 2 1/2" size... Underwriter approved type in 5 1/4" and 6 1/4" sizes... Variety of ends for different kinds of pipe. (See Section 12).



### Gate Valves

#### AWWA Non-Rising Stem

Hub, flanged, hub and flanged...  
Spigot, hub and spigot, flanged and spigot...  
Mechanical joint...  
Flanged and Mechanical Joint...  
Universal, flanged and Universal, screwed...  
Hub for asbestos cement...  
Hub for steel pipe...

#### AWWA Sliding and Rising Stem

Flanged...

#### AWWA Outside Screw and Yoke

Hub, flanged, screwed...

(See section 13).



### Cut-In or Tapping Valves

Tapping valves for use with tapping sleeve or cross... Calked and mechanical joint types...  
Conventional or "O" ring stem packing...  
With or without indicator post flange... Cut-In Sleeve and Valve with conventional or "O" ring stem packing. (See Section 14).



### Sleeves

Split repair and tapping... Calked or mechanical joint types... Tapping cross with calked or mechanical joint also available. (See Section 14).



### Inserting Valves

For inserting into mains while under pressure... Non-rising stem with Conventional packing... Gate valve mechanism is identical to Mueller AWWA Gate Valves. (See Section 15).



### Valve Boxes

Two or three-piece type, extension pieces, adapters and bases... Roadway screw type with arch or flange base and extension. (See Section 16).



### Miscellaneous Valves

Check, flap, mud or plug drain valves, shear gates, floor and bench stands, and indicator posts. (See Section 17).

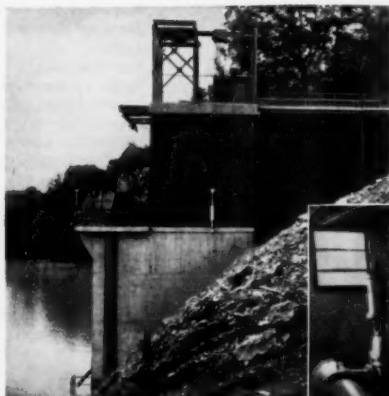
Visit our new miniature water works distribution display at the main entrance of the convention hall in Atlantic City, May 12-17, 1957.



**MUELLER CO.**  
**DECATUR, ILL.**

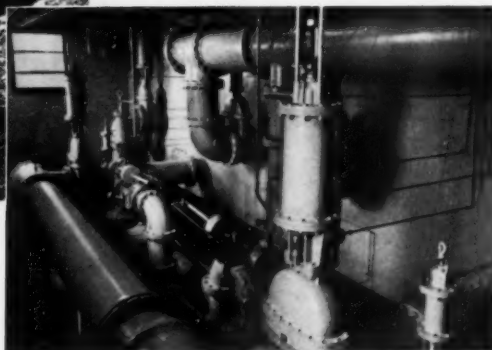
Factories at: Decatur, Chattanooga, Los Angeles;  
In Canada: Mueller, Limited, Sarnia, Ontario

*Since 1857*



Interior, filter plant pipe gallery: RAMUC Utility Enamel safeguards piping, walls and ceilings.

118'-high automatically operated water intake and pumping station. Interior walls, ceilings, valves, etc., protected and beautified with RAMUC® Utility Enamel. Attractive GLAMORTEX® Enamel guards exterior steelwork.



## INERTOL® PAINTS GUARD REMOTE CONTROL PUMPING STATION

AT CLEVELAND, TENNESSEE'S unique new Water Treatment Plant, a push-button in the filtration plant starts and stops operations in the pumping station five miles away. All other functions are automatic. A minimum of maintenance is required.

INERTOL coatings contribute to this cost saving because they work for years without maintenance. Consulting Engineers Wiedeman and Singleton, Atlanta, Ga., specified INERTOL 100% for both filter plant building and pumping station. They've specified INERTOL since 1939.

Buy INERTOL paints direct from the manufacturer. Shipment within three days. Write today for free booklet J-754, "Principal Types of Protective Coatings."

**SPECIFICATIONS FOR RAMUC UTILITY ENAMEL**  
A glossy chlorinated natural rubber-base coating in color for nonsubmerged concrete, steel and indoor wood surfaces.

(Needed on steel only where surfaces are subjected to heavy condensation and are almost constantly wet or subjected to chemical fumes. In all other cases use GLAMORTEX Enamel, excellent alkyd-resin coating in color.)

**Steel Surfaces. Colors:** Color chart 560. **No. of coats:** 3 over primer. **Coverage:** 300 square ft. per gal. per coat. **Approx. mil thickness per coat:** 1.2. **Drying time:** 24 hours. **Primer:** Shop Primer — INERTOL Rust-inhibitive Primer No. 621; Field Primer — INERTOL Quick-Drying Primer No. 626. **Thinners:** INERTOL Thinner No. 2000-A, for brushing; No. 2000, for spraying. **Application:** Brushing: RAMUC Utility Enamel — brush type: as furnished. Spraying: RAMUC Utility Enamel — spray type: add sufficient Thinner 2000 to secure proper atomization.

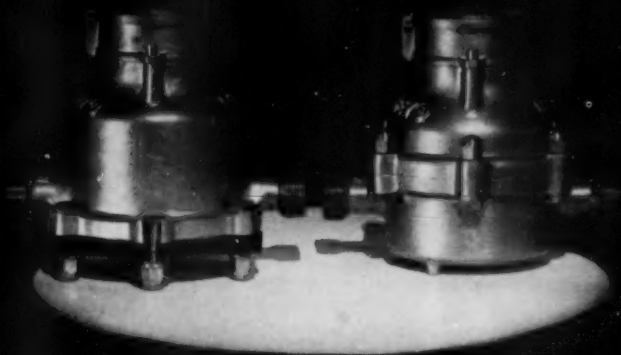
(Write for RAMUC specifications for concrete surfaces, and for GLAMORTEX specifications for steel and indoor wood.)



® A complete line of quality coatings for sewage, industrial wastes and water plants.

**INERTOL CO., INC.**

484 Frelinghuysen Avenue, Newark 12, N. J. • 27-G South Park, San Francisco 7, Calif.



# HERSEY

A name that has been preëminent in  
the Water Works field for 72 years

**HERSEY MANUFACTURING COMPANY**

**SOUTH BOSTON, MASS.**

BRANCH OFFICES: NEW YORK — PORTLAND, ORE. — PHILADELPHIA — ATLANTA — DALLAS — CHICAGO  
SAN FRANCISCO — LOS ANGELES

*New!*

## TIME-~~S~~AVING COMBINATION LEAK DETECTOR-PIPE LOCATOR



### THE M-SCOPE MASTER Electronic Witch Combination

You're looking at the much-talked-about **NEW M-Scope**... the only dual-purpose that detects leaks **and** locates pipe. Its rugged, highly efficient electronic circuit, plus ease

of use and portability, make this instrument one of the most welcome contributions to the water works industry.

*Quick Facts*

LOCATING A LEAK  
AT THE VALVE



FINDING A LEAK  
UNDER PAVEMENT



ONE MAN  
OPERATION



LOCATING  
A SERVICE

For greatest convenience and reliability, the M-Scope MASTER is equipped with a

**built-in battery tester** for instant checking of battery condition in the field or elsewhere.

WRITE TODAY FOR SPECIFICATIONS AND PRICE!

PIPE LINE EQUIPMENT  
**JOSEPH G.  
POLLARD  
CO., INC.**  
PIPE LINE EQUIPMENT

Place your next order with POLLARD

If it's from POLLARD... It's the Best in Pipe Line Equipment

NEW HYDE PARK • NEW YORK

Branch Offices: 964 Peoples Gas Building, Chicago, Illinois  
333 Candler Building, Atlanta, Georgia

# USE NORTHERN GRAVEL for RAPID SAND FILTER

**FILTER SAND SPECIFICATIONS** are carefully laid out. The Effective Sizes and Uniformity Coefficients used by Consulting Engineers and also recommended by the American Water Works Association are the result of long years of research and experience.

The Northern Gravel Company is equipped to give you prompt shipment whether it be one bag or many carloads, exact to specification. Filter sand can be furnished with any effective size between .35 MM and 1.20 MM.

**CHEMICAL QUALITY** of the filter sand is also important. It must be hard, not smooth and free of soluble particles. This requires perfect washing, and grading facilities. We have every modern device for washing, drying, screening and testing.

**FILTER GRAVEL** supporting the Filter Sand Bed must be, in turn, properly graded to sizes calculated to support the Filter Sand, and be relatively hard, round and resistant to solution.

The new Northeast Station in the City of Detroit, which is scheduled for completion in 1956, is one of the major projects included in the water department's expansion program. The Northern Gravel Company furnished 120 carloads of filtering materials for the 48 rapid sand filters incorporated in this plant.

Northern Gravel has no equal in facilities and our reserves of both sand and gravel are inexhaustible. Northern Gravel Company has been in business over 40 years. We guarantee uniformity of products and our records enable us to duplicate your requirements on short notice. Our location is central and we have commodity rates in every direction.

## NORTHERN GRAVEL COMPANY

Muscatine, Iowa

P.O. Box 307

Phone: Amherst 3-2711

# 1879—ROSS—1879

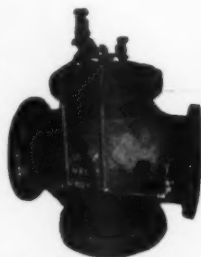
## *Automatic Valves*

**ALTITUDE VALVE**

Controls elevation of water in tanks, basins and reservoirs

1. Single Acting
2. Double Acting

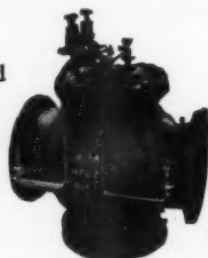
Maintains safe operating pressures for conduits, distribution and pump discharge

**SURGE-RELIEF VALVE****REDUCING VALVE**

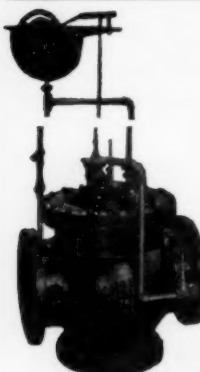
Maintains desired discharge pressure regardless of change in rate of flow

Regulates pressure in gravity and pump systems; between reservoirs and zones of different pressures, etc.

A self contained unit with three or more automatic controls

**COMBINATION VALVE**

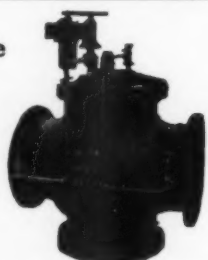
Combination automatic control both directions through the valve.

**FLOAT VALVE**

Maintains levels in tank, reservoir or basin

1. As direct acting
2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

Electric remote control—solenoid or motor can be furnished

**REMOTE CONTROL VALVE**

Adapted for use as primary or secondary control on any of the hydraulically controlled or operated valves.

***Packing Replacements for all Ross Valves Through Top of Valve***

**ROSS VALVE MFG. CO., INC., P. O. BOX 593, TROY, N. Y.**



## TO MEET UNPRECEDENTED DEMANDS FROM INDUSTRY...

### MAIN WATER SUPPLY LINES BY AMERICAN PIPE AND CONSTRUCTION CO.

The challenge of furnishing water to Rancho San Pedro Industrial Center, one of the nation's fastest growing planned industrial areas, located between Los Angeles and Long Beach, forced privately-owned Dominguez Water Corporation to plan extensive additional facilities for its water system. Since 1951 ideal conditions have attracted more than 50 important industries and 10,000 new homes to the area the company serves. Alert Dominguez Water Company officials anticipated increased industrial and domestic needs and launched an expansion program keeping pace with unprecedented demands.

For example, during the past 24 months, Dominguez has ordered American Concrete Cylinder Pipe for 11 separate installations, predominantly main water transmission lines. The company also tapped the Los Angeles Metropolitan Water District's supply lines for a supplemental source, using 42" American Concrete Cylinder Pipe. This augmented a system formerly supplied by wells and reservoirs alone.

T. V. Tallon, Chief Engineer and General Manager of Dominguez Water Corporation, has expressed his pleasure with the cooperation and service of American Pipe

and Construction Co., "During our present expansion program, American Pipe has consistently met our delivery deadlines - some of them urgent - yet held to the same high manufacturing standards as first attracted American to our attention."

American Pipe makes available 50 years of experience and extensive production facilities to help solve any water supply problem. There is a type of American Pipe to meet any requirement. Write or phone for information.



**Mail address:** Box 3428 Terminal Annex, Los Angeles 54

**Main offices and plant:**

4635 Firestone Blvd., South Gate, Calif. Phone LOrain 4-2511

**District sales offices and plants:**

Hayward and San Diego, Calif., Portland, Ore., Phoenix, Ariz.

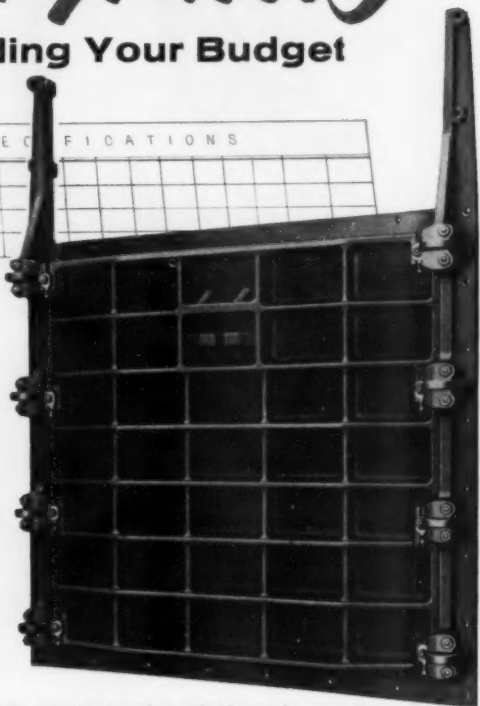
**District sales representatives:**

Seattle and Spokane, Wash.

CONCRETE PIPE FOR MAIN WATER SUPPLY LINES, STORM AND SANITARY SEWERS, SUBAQUEOUS LINES

Made to Fit  
**Everything**  
... Including Your Budget

Chapman  
*Standard*  
Sluice  
Gates



No matter what your requirements are, installations, *in every case*, are easy with Chapman Standard Sluice Gates. The reasons are soon obvious.

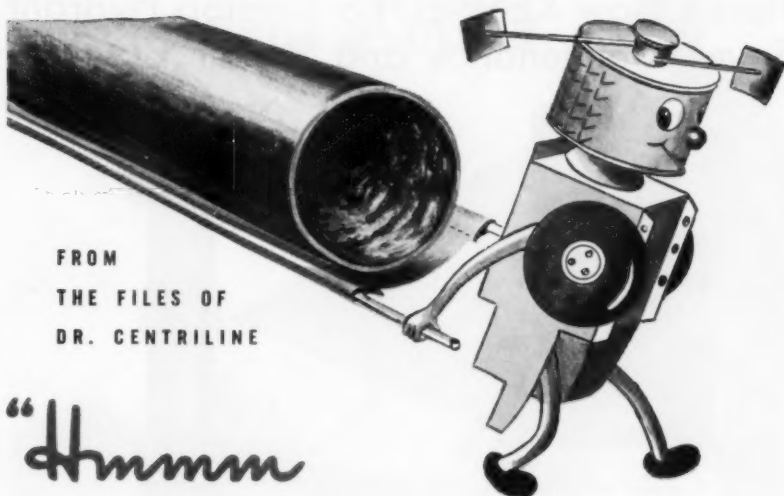
All component parts . . . discs, guides, hooks and wedges . . . in more than 300 available types and sizes are standardized. That means they're interchangeable. Regardless of your specifications, you always get a quick perfect fit. There's nothing hit or miss about it. No expensive, time consuming match-marking. No extensive field alterations. You get a quick, perfect fit *at lowest possible cost*.

Even after installation, your savings never stop. These standardized, interchangeable parts are easily replaced. Your maintenance cost for keeping your sluice gates in excellent working order is low, *the lowest possible*.

This applies to all Chapman Standard Sluice Gates . . . for high or low head, seating or unseating pressures, large or small water areas . . . with manual, hydraulic or electric motor operation. All available in the fastest possible time.

If you don't have a copy of our Catalog 25-A readily on hand, write for a new fresh copy.

**The CHAPMAN Valve Manufacturing Co.**  
INDIAN ORCHARD, MASSACHUSETTS



FROM  
THE FILES OF  
DR. CENTRILINE

# "Hmmm ... a bad case of corrosion"

CASE # 7841

- PATIENT:** 8 Miles of 16" and 12" Cast Iron Water Supply Lines in Abington-Rockland (Mass.) Water District.
- SYMPTOMS:** Lack of water and pressure during periods of high demand requiring restrictions in the summertime.
- DIAGNOSIS:** Poor circulation due to regrowth of tuberculation after cleaning. Available water could not be delivered to consumers.
- TREATMENT:** The lines were cleaned and cement lined in place without interrupting service to consumers. In less than 8 weeks the entire job was completed.
- RESULTS:** Patient now sound and healthy; pipe capacity permanently doubled, no further summer restrictions, future maintenance costs were eliminated.

*If your lines also show signs of suffering from corrosion, leakage or tuberculation, investigate the Centriline Process. Cleaning and cement lining in place has been a successful remedy for over 1,000 miles of water supply pipelines. Centriline hasn't lost a patient yet.*

## CENTRILINE CORPORATION

*A subsidiary of the Raymond Concrete Pile Company*

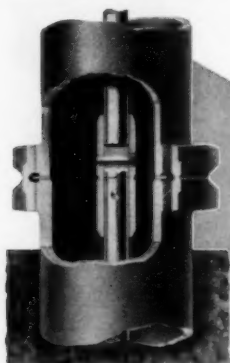
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Branch Offices in Principal Cities  
of the United States,  
Canada, and Latin America.



## Here's How KENNEDY'S Safetop Hydrant Saves Maintenance and Repair Costs . . .



Construction of Safety Breakable Section of KENNEDY SAFETOP Fire Hydrant.

Fig. 1280  
KENNEDY SAFETOP  
FIRE HYDRANT



A broken KENNEDY SAFETOP . . . and all you need to repair it. When struck a smashing impact and broken, here's how the KENNEDY SAFETOP fire hydrant breaks. A clean break at the Safety Breakable Section means no damage to the water and expensive parts of the hydrant and no loss of water.



With this set of breakage repair parts, the repair job can be done by one man, with a few standard tools, without excavation. The entire repair job takes about fifteen minutes.

KENNEDY SAFETOP fire hydrants are designed and constructed with these outstanding features: Protection against flooding upon accidental breakage; maximum supply of water at nozzles available from supply main; minimum friction loss from inlet elbow to nozzle outlets; positive, complete drainage after operation to prevent freezing; leakproof valves and gaskets; easy fast inspection and renewal of operating parts.

Both KENNEDY SAFETOP and KENNEDY STANDARD fire hydrants are non-flooding compression type and are available in 4", 4½", 5" and 6" sizes. See how KENNEDY fire hydrants can save you time and money. Write today for complete details.

• WRITE TODAY FOR COMPLETE DETAILS



**KENNEDY VALVE MFG. CO.**

1603 E. WATER ST.—ELMIRA, NEW YORK  
VALVES • PIPE FITTINGS • FIRE HYDRANTS

• OFFICE AND WAREHOUSES IN NEW YORK, CHICAGO, SAN FRANCISCO, ATLANTA • SALES REPRESENTATIVES IN PRINCIPAL CITIES •

**Into the ground  
with ease,  
and for keeps**



#### **K&M ASBESTOS CEMENT PIPE**

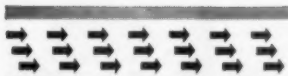
**It's the modern pipe!** Easy installation under any weather and ground conditions is just one of the advantages of K&M Asbestos-Cement Pipe. Other advantages: Permanently smooth non-tuberculating bore; non-corroding inner and outer surfaces; high resistance to electrolytic action; permanence of joint obtained quickly with exclusive K&M "Fluid-Tite"® Coupling.

K&M Pressure Pipe meets A.W.W.A., A.S.T.M. and U.S. Federal Specifications, and has Underwriters' Laboratories approval for all sizes (pipe and couplings) in Class 150.

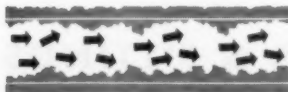
**FOR GRAVITY SEWER SYSTEMS,** K&M Sewer Pipe is the low-cost answer. "Fluid-Tite" Coupling makes permanent tight joint, prevents infiltration and root entrance.

**FOR HOUSE-TO-SEWER CONNECTION,** K&M Building Sewer Pipe and 2-Step couplings round out the K&M family of asbestos-cement pipe.

Get the whole story on the modern pipe from the K&M distributor. And visit us at our booth at the A.W.W.A. Convention, Convention Hall, Atlantic City, N.J., May 12-17, 1957.



After many years, K&M Pipe hasn't tuberculated, bore remains unchanged, and full flow continues.



Old-fashioned pipe tuberculates over the years, requires higher pumping pressure, frequent cleaning.

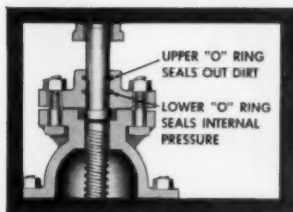


**KEASBEY & MATTISON Company • Ambler, Pennsylvania**  
In Canada, it's ATLAS ASBESTOS CO., Ltd., 5600 Hochelaga St., Montreal, P. Q.  
for "CENTURY" Pipe and "FLUID-TITE" Couplings

## CRANE expands A. W. W. A. line for special needs

### Water corrosive? Use CRANE valves with all-bronze trim

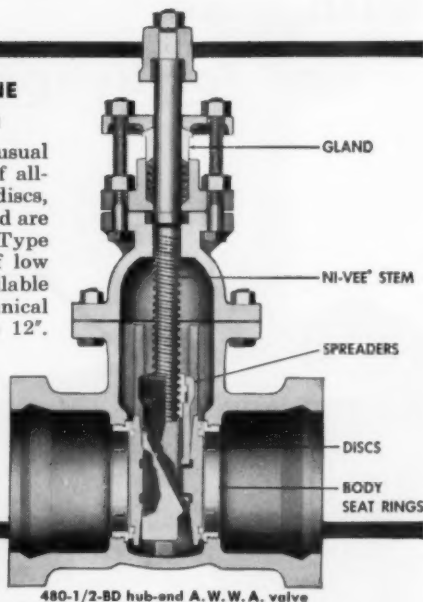
This Crane valve is for use where unusual water conditions require the use of all-bronze internal parts. Body rings, discs, upper and lower spreaders, and gland are of solid bronze. Stem is "Ni-Vee"® Type A bronze, a copper-nickel alloy of low zinc content. These valves are available from stock in hub, flanged and mechanical joint ends—in all sizes from 2" to 12".



### Double "O" ring stuffing box now available

Another feature now available in Crane A.W.W.A. non-rising stem valves is an "O" ring stuffing box. Two Buna-N "O" ring seals hug the stem tightly. Lower ring acts to seal the internal pressure; upper ring is an external dirt seal and reserve pressure seal. Valves with "O" ring stuffing boxes are available with hub, flanged, mechanical joint ends—in all sizes from 2" to 12".

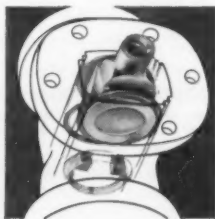
®"Ni-Vee" is the registered trade-mark of International Nickel Co.



### Features of CRANE A.W.W.A. Valves justify their choice

Simple, 4-part double-disc assembly—2 discs, 2 spreaders. Discs are free to rotate—minimizing concentrated seat wear. Discs cannot fall out or jam. Easy opening and tight closing assured. Valves have much longer service life.

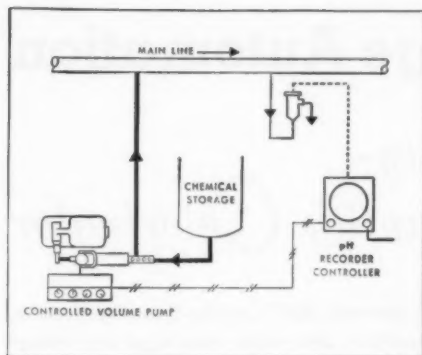
For complete details of Crane A.W.W.A. valves, write for circular 2108.



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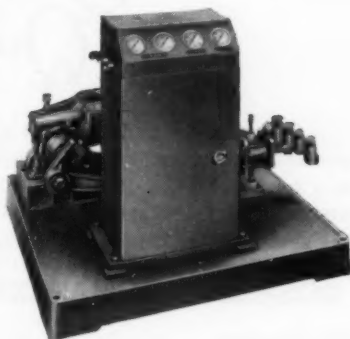
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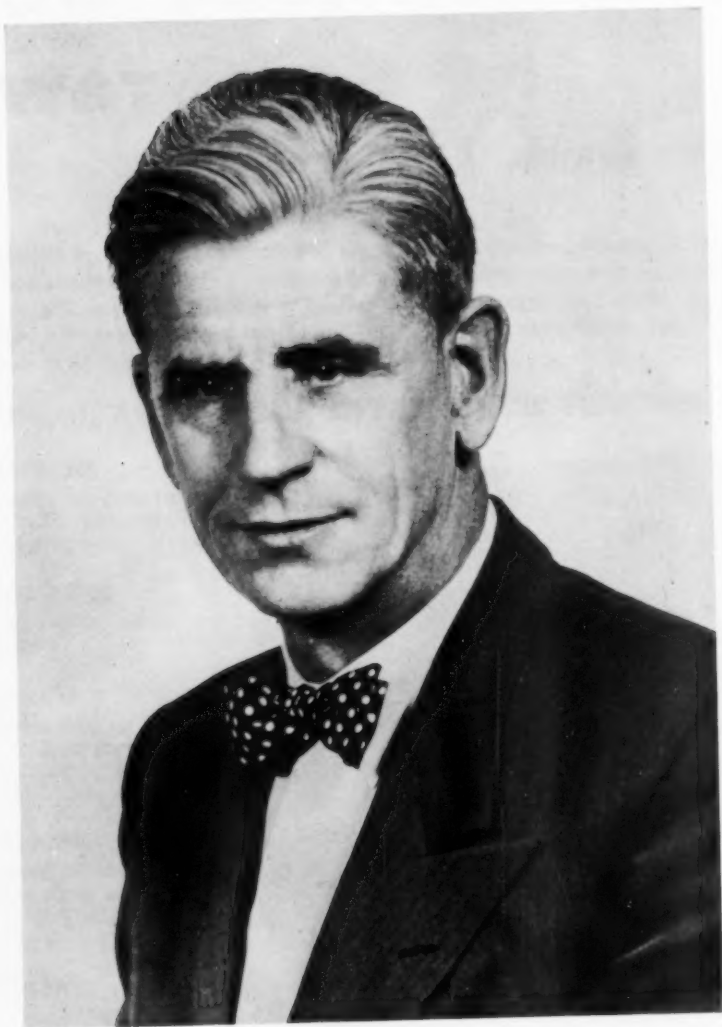
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### Disposal of Radioactive Wastes

Abel Wolman

*A paper presented on Mar. 11, 1957, under the sponsorship of AWWA, at the Engineer's Joint Council Nuclear Eng. and Science Congress, Philadelphia, Pa., by Abel Wolman, Prof. of San. Eng., Johns Hopkins Univ., Baltimore, Md.*

**A** LOGICAL preamble to this paper may be found in the admirable summary statement of the report released by the National Academy of Sciences on the Biological Effects of Atomic Radiation. The statement, appearing in a report to the public (1), issued in the early summer of 1956, is as follows:

Now we must look into the very tangled problem of how the radiation gets to the people. It is a long way from Eniwetok to Chicago or Bombay. A power station in Oslo or Moscow is a far remove from Johannesburg. Yet all these places are in the same ocean of air; all are surrounded by the interconnecting oceans of water. English grass has been sprinkled with strontium 90 from Nevada. And English cows have eaten it. Plankton in the North Sea has very likely taken up some of the radioactivity being dumped there from a British atomic reactor. Where did the ocean currents then carry this plankton? What fish fed on it? Who ate the fish?

Between the potential sources of man-made radiation and the people of the world is a vast, complex connecting network. It includes the air, the rivers and oceans, and the plant and animal life which form the links in the chain of our food supply. How radiation is distributed or how its distribution can be controlled is a problem that calls for the combined efforts of meteorologists, oceanographers, agricultural scientists and experts in the disposal of radioactive wastes.

Within this setting, in an age of maximum advance in the development of sources of radiation, what is the problem of radioactive wastes? Much has already been written and published on this complex subject. For the purposes of this review it is unnecessary to repeat in detail the origins of these wastes at various stages of the program for the peaceful development of the uses of atomic energy. Such sources have been spelled out with elaboration in the technical press. Varying composition, radioactivity, and toxicity of

wastes stem from every step in the production of atomic energy—from the mining of uranium and other raw materials to the ultimate reprocessing of fuel and byproducts. They may be of solid, liquid or gaseous nature.

In the handling of raw materials, exposure to the radioactive gas, radon, has to be controlled; in the processing of uranium concentrates, the dust of uranium compounds is a possible hazard. Problems also arise from concentrations of fissionable uranium or plutonium which could, if improperly handled, initiate a chain reaction and throw off very powerful radiations. Plutonium and various other substances of importance in the atomic energy program are poisonous if allowed to enter the body. Problems arise also from the processing of materials which have been passed through reactors; from radioactive industrial wastes; and from the testing of atomic weapons. Many of these same problems arise with development of nuclear power by private, city, state, and cooperative organizations, or with industry's efforts to advance other peaceful uses of atomic energy.

Public hazards could arise from excessive releases of process gases; from plant or reactor ventilation which might contain radioactive gases and airborne radioactive material; from reactor coolants where these are released to the environment; from radioactive fallout after weapons tests; from radioactive industrial wastes that are not stored; and from miscellaneous contaminated materials—tools, machinery, clothing, etc., from atomic energy installations (2).

At each of the steps noted above situations arise which require detailed understanding, sharp control, and continuity of monitoring to provide safety from exposure for the industrial worker and the surrounding population. The safeguards taken by the Atomic Energy Commission (AEC) to protect

worker and public have been remarkably effective in the commission's manifold operations.

National and international standards have been established for the amounts of radiation to which humans may be exposed with a reasonable degree of assurance of health and safety. These standards have been the result of a large amount of experiment, inquiry, judgment, and evaluation. Data on the behavior of humans after varying degrees of exposure to radiation are still insufficient, however, to assure rigid and inflexible limitations. Such studies are being pursued with vigor, but perhaps at a rate still too slow to develop firm answers as rapidly as required. It should be remembered that zero radiation is the optimum environment and that additional exposures above background amounts, must be viewed with care.

The geneticist tells us that there is no safe dose. Each dose, however small, causes a risk of genetic harm proportional to the dose. Because of these facts and many unknowns, the so-called "permissible dose," first set at 0.5 roentgen per 5-day week by a national committee in 1935, was lowered in 1946 to 0.3 roentgen per 5-day week and in 1956 to 5 roentgens per year or approximately 0.1 roentgen per 5-day week.

These considerations establish the reasons why the handling of radioactive wastes becomes of major significance to modern society.

W. Kenneth Davis of the AEC has recently summarized succinctly the present situation in the following terms (3):

A large nuclear power reactor will produce large volumes of waste fission products and other radioactive debris.

Storage in tanks is not a permanent nor adequate solution. New methods are under development but the ideal solution in terms of cost and positive control of the radioactivities still appears to require intensive work. This also is a problem in which chemists and chemical engineers must work in close collaboration with sanitary engineers.

Present practice, particularly insofar as high-level radioactive wastes from chemical fuel processing are concerned, may be summarized in the observation that wastes are not being disposed of in the sense in which we use this term with more familiar domestic and industrial wastes. Wastes of major significance are being reduced to smaller volume and manageable state so that they may be either stored or released to the natural environment under rigid controls. Even with wastes hitherto defined as of low-level radioactivity, release to nature via the atmosphere, the soil, or receiving bodies of surface waters poses increasing issues for the future as the development of nuclear power and of industrial sources of heat increases.

These comments are not only pertinent, but need to be emphasized and re-emphasized, because many industrialists and other workers in this field have the impression that the disposal of radioactive wastes has been accomplished, that costs for so taking care of waste products are of no real significance, and that practicable procedures to accompany the development of the industry are now at hand. None of these assumptions is valid. As a matter of fact, tens of millions of dollars annually are now being spent by the AEC for detailed exploration in universities, research institutes, private industry, and in the commission's own laboratories, for improving fuel processing

operations. The efforts are directed toward developing greater economy in these processes and in reducing volume and strength of the resultant wastes.

One cannot view the problem as solved, on the assumption that removal from a plant operation site of high-level radioactive wastes by the AEC is the equivalent of a disposal method in the sense that that term is commonly used. The commission has made quite clear in its public pronouncements that it must look increasingly to industry, to universities, research institutes, and others for working promptly and actively towards solutions of these critical problems.

### Control Practices

Some general comments upon the eight current and prospective practices in the control of radioactive wastes are here appropriate:

#### 1. *Transportation*

The present practice is to transport wastes of significant radioactivity to selected central points either in the form of fuel materials or in wastes of different origins. The transportation of such materials is expensive. Their packaging, their protection against normal or accidental exposure of persons in transit, their handling and storage at terminals are also costly. They pose a number of significant questions in relation to transportation routes, control monitoring systems, and storage facilities in reasonably isolated areas.

No one may look forward with equanimity to the expansion of significant holding areas of wastes, without being confronted with problems and economics of transport. Alternatives to transport, with safe local processing, or modification in fuel technology must be

found as the industry progresses. This point need not be labored, but it is so frequently forgotten because of the present responsibility of the AEC for the removal of spent fuel and wastes. Such a paternal practice is unlikely to be perpetuated indefinitely.

As the United States assumes a leadership throughout the world in the field of atomic energy production, it also assumes the responsibility for fuel supply and for spent fuel processing. The control of transportation hence becomes of international as well as national import.

### *2. Recovery for Use*

In the discussion of recovery for use, the realities should be kept separate from the optimistic press releases, including some of scientific origin. If one reviews the latter with care, it is soon evident that the amounts of money to be anticipated from the recovery of useful materials from high-level radioactive wastes are still in the realm of hopes for the future rather than of immediate promise. Undoubtedly the future may disclose increasing portions of wastes recovery for useful purposes. That time is not at hand. In so complex a field prophecy is hazardous.

Recovery of materials may pay for some of the waste processing necessities. If the precedents in other industrial wastes are any guide, the atomic energy industry is a very long way from this goal. Perhaps, the very hazard of these wastes may push this industry more rapidly toward economic recovery of wastes materials than has been the case in most other industrial processes. This result, however, must be listed as a hopeful prospect, rather than as present accomplishment.

### *3. Disposal at Sea*

Materials of some radioactivity have been and are being disposed of at sea.

Their levels of radioactivity are low. The total quantities now disposed of in this manner in this country and in the western world are small. Even with these materials the costs are high, because packaging and transportation from inland sources to appropriate places at sea add up to absolute costs of some magnitude. Relative costs, for such low-level wastes, in the industry from which they stem, may be low.

As far as the author is aware, no high-level radioactive wastes are being disposed of at sea by any country. Much more must be known about the behavior of the sea before it can or should be used as a safe disposal ground for the atomic power industries. Those who look to the sea hopefully for this disposal ground must await a great deal of investigative diagnosis of the various oceans before national or international permission should be granted.

For example, little is known about the currents at depths of 600 to 30,000 ft. Much will have to be known about their behavior, the velocities at which they move, the directions in which they proceed, and the time of retention from the depths to the appearance at the surface. One of the many enterprises which will be under way in the International Geophysical Year (Jul. 1, 1957-Dec. 31, 1958) will be concerned with attempting to gather this essential information. Such data should shed some light on the age, the movement, and the fate of waters in those depths.

Such investigations, of course, are already under way both on the Atlantic and the Pacific oceans, with the major support of the AEC. They are so supported because the commission recognized in its most recent annual report (2) to the Congress that "the safe handling and final disposal of wastes is important to the successful application of nuclear energy to the peaceful uses."

The commission itself poses a number of basic questions with respect to the sea which will have to be answered. They are briefly:

The amount of radioactivity that would be picked up in ocean spray and held in the atmosphere.

How radioactivity would affect sea life and human foods.

The extent of deep water flow from cold latitudes to the Equator and the rate at which the deep water mixed with surface water.

The eventual dilution of deeply deposited radioactivity if it became available to sea life, and the effect of eventual surface concentrations of radioactive materials by various forms of sea life.

#### 4. Storage Tanks

The practice of holding wastes in tanks at a number of installations was not a fortuitous choice. It was undertaken after a great deal of consideration of alternative methods of holding. Their location and operation had been determined with care and the monitoring of their behavior is diligently pursued.

Because of the failure to develop any better method, some have regarded the practice as "standard." The cost in absolute figures remains high. In terms relative to the cost of production of nuclear energy the figure is low. Problems of structural behavior, of corrosion, of life expectancy, and of detailed control of storage tanks remain. Some better and more economic way of handling these materials is still to be found.

The stipulation that such wastes should be held for long periods of time in order to provide for consequent decay had advantages when the number of such units required for storage was low. As time goes on, their number and their location will pose added problems.

The advantages resident in storage are clear. Storage provides a managed, controlled system. The storage units contain the wastes materials for possible future use for reprocessing. They restrain the materials from moving at large into the natural environment, where their control would be consistently and regularly reduced.

Storage of liquids, semi-liquids, and solids, present a premium, however, upon space. In some production areas, space for such holding for all wastes of this nature is becoming a problem. Within 10 years new storage and burial grounds have become necessary in some of the areas.

If nuclear energy development occurs on a wide geographical base, particularly in increasingly dense population centers, storage of many types will confront the industry with space and site selection problems.

#### 5. Disposal in Deep Wells

Much consideration has been given over the last 4 or 5 years to disposing of wastes in wells of 5,000- to even 20,000-ft depths. Such proposals have rested upon the assumption that the wastes might be injected into such depths in carefully, geologically selected spots, where the materials might be retained with safety and where assurance may be relatively high that the passage of nuclides would not affect or destroy other natural resources. These specifications have not yet been met. Selection of areas reasonably guaranteed to be safe for the long future has moved forward only slowly. Procedures for injecting waste materials into such depths at any reasonable rate of disposal have not yet been evolved. Costs have not been determined.

In this method, again, there are some industrial waste precedents, particularly with oil brines. These prece-

dents, however, offer no immediate hope by analogy, because of the ever-present necessity of guaranteeing long-time holding and decay of toxic materials. Work on this procedure continues. It is not unfair to say that the answer is not yet at hand.

It must be demonstrated, almost site by site, what the vertical and horizontal displacements of radioactive elements are likely to be. Normal gross geologic predictions for either deep wells or other soil dispersing areas, are no longer safe for specific decisions. The gross characteristics have proved to be too broad in nature to be specifically useful for any particular formation or location.

The struggle to obtain a greater perfection of predictability as to the behavior of soils, surface or deep, under the impact of these wastes is proceeding and may ultimately result in extremely helpful principles, criteria, and tests.

#### 6. *Dumping*

Historically, every industry at one time or another resorted to dumping wastes into sumps, lagoons, streams, and atmosphere. Orderly use of many of these techniques, with carefully controlled monitoring, has proved only moderately successful with wastes far less hazardous than those under discussion.

It may be predicted that government regulation and control in the future with respect to atomic energy wastes will be increasingly restrictive rather than increasingly lax. This is not meant to imply that orderly use of such procedures would be prohibited. It does mean that continued use of such procedures is unlikely to offer permanent answers.

#### 7. *Solid Fixation Processes*

For more than 5 years, a number of laboratories in this country have been actively studying solid fixation processes as a method of handling wastes. Their objective has been primarily to reduce volume, to restrain release of radioactivity and to make transport and storage manageable. None of these efforts has so far produced a material which can be disposed of. Some give promise of producing a mass which might be stored for long periods of time, again with monitoring and supervision. All of the processes at the moment are costly. It is too early to say which, if any, of the current efforts will result in a satisfactory economical product for long-term storage or for earth disposal. For the most part, the products now resulting, on a laboratory or pilot plant scale, still have to be shipped to remote and carefully administered areas for final disposal.

#### 8. *Salt Mines*

Salt mines are great in acreage and very deep. They occur in strategically located spots. It is not surprising, therefore, that they are under detailed consideration for the purposes here discussed. Their use confronts the atomic energy industry with the problems, inherent in these wastes, of injection, high heat production, and potential of explosion. No actual use has so far been made of these areas, or other types of mines, because criteria for success have not yet been reasonably demonstrated. Work on these possibilities continues.

#### Conclusions

Many of the procedures so far suggested in this difficult and complex field make clear that a high degree of admin-

istrative supervision must be contemplated for the future. Radiation inventory and storage will increase. The public will demand an increasing continuity and efficiency of administrative control.

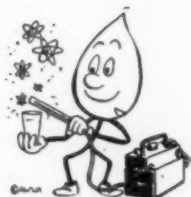
The geography of that control will be international as well as national. The complexity of the control is such that decentralization of supervision among the states and local subdivisions is equally apparent for the future. Such supervision will rest upon agreed national and international standards and criteria.

Regardless of present methods of disposal or of holding, whether in the atmosphere, the sea or the earth, no method now exists which is both cheap and permanently satisfactory. No method, incidentally, can be left to indiscriminate application, much as one might prefer to avoid the kind of detailed administrative control which appears on the horizon.

It has become a cliché to point out that, in the development of any of these practices, technologically or administratively, the combined forces of the best of our scientific talents will be required. It is truer today than ever before in our industrial development that solutions to the problems here posed must come from the combined efforts, among others, of geologists, chemical technologists, sanitary engineers, health physicists, medical officers, biologists, and petroleum engineers. In these interdisciplinary research and development projects, the AEC has pursued strikingly broad policies.

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## Uniformity of Fluoride Ion Concentration in Newburgh, N.Y., Distribution System

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—Floyd B. Taylor—

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*A contribution to the Journal by Floyd B. Taylor, Sr. San. Engr., National Institutes of Health, USPHS, Bethesda, Md.*

THE question, still current, of whether uniform fluoride ion concentrations can be maintained in public water supplies can be answered in the affirmative.

Recently, a statistical analysis of fluoride ion test data from several communities was made for Newburgh, N.Y. The analysis showed a rather normal frequency distribution with a narrow spread around the figure of 1.1 ppm—the goal of the Newburgh program (1). The data described below covered a 2-year period.

### Newburgh Water Supply

Newburgh obtains its public water supply from upland surface streams impounded in a large raw water reservoir. Water is treated in a modern plant by coagulation, aeration, sedimentation, rapid sand filtration, chlorination, and, since May 2, 1945, fluoridation. A dry-feed, volumetric, manually controlled fluoridator applied sodium fluoride to a large pipe carrying water from the filters to the clear well. When fluoridation was first begun, the point of application was the clear well itself, but as varying results were obtained, the point of feed was changed to that first described and then, with the addition of baffles in the clear well, uniformity was achieved.

Tests for fluoride ion were made daily by a competent chemist in the

filter plant laboratory using *Standard Methods* (2) procedures, and check tests were made frequently in the New York State Health Department laboratories. The samples tested were collected at points on the distribution system.

### Definitions

The following definitions are of statistical terms as used in the article.

*Range* is the difference in fluoride ion concentration between an upper and a lower value in a series.

*Mean* is the arithmetic average fluoride ion value of a series.

*Standard deviation* is a measure of variation. When considered together with the mean, a central range containing about  $\frac{2}{3}$  of the test results in the series—that is, the mean fluoride ion concentration plus and minus the standard deviation is the range within which fall about  $\frac{2}{3}$  of the test results of the series.

*Frequency distribution* is a series of measurements which describes the progress of a process—in this case, fluoridation.

*Cumulative distribution* is the successive total of samples with a fluoride ion concentration up to and including a given value in the series. It is expressed as a numerical and percentage figure. For example, in Table 3, from the low value of 0.7 ppm to and includ-

ing 0.85 ppm, there were a total of 22 test results, or 1.21 per cent of the total of 1,820 test results in the series.

*Percentile* is that percentage of test results falling in any given or selected fluoride ion concentration range.

*Median* is that fluoride ion value above and below which 50 per cent of the sample test results fall.

### Interpretation of Data

In Table 1 \* are shown frequency and cumulative distributions of the results of 1,388 fluoride ion tests performed by the Newburgh city chemist. The frequency distribution is shown graphically in Fig. 1, and Fig. 2 illustrates the shape of the cumulative distribution. Table 2 and Fig. 3 and 4 give corresponding facts on 432 samples analyzed in the laboratories of the New York State Health Department. Table 3 and Fig. 5 and 6 show the combined data for the total of 1,820 fluoride ion test results.

The mass of data, which statistically represents a large sample, demonstrates several facts:

1. Precise control over fluoridation was achieved by the operators of the Newburgh public water supply.

2. The mean values of 1.07, 1.10 and 1.08 ppm vary little from the value of 1.1 ppm—the goal of the operators. The compactness of the test results about the mean value is demonstrated by the small standard deviations of 0.084, 0.087, and 0.085 ppm, and by the shape of the graphic representations of the frequency distributions.

3. The samples were collected at a frequency of about 2.5 per day for a

2-year period. The cumulative frequency curves, although constructed from discreet items, may be used to estimate how the fluoride ion concentration varied through time. That is, the percentiles may be considered as portions of time during which the fluoride ion concentrations were at their shown value. In only 1 per cent of the samples were fluoride ion test results below 0.9 ppm, a desirable minimum. At the other end of the scale, in only 2 per cent of the samples, were the concentrations above 1.3 ppm, and in none of the samples did they exceed 1.5 ppm.

### Conclusion

It is concluded that fluoridation of a public water supply may be precisely controlled where adequate equipment is available, where properly trained personnel operate the equipment, and where reasonable care is exercised in the operation.

### Acknowledgment

The writer wishes to express his appreciation to the Superintendent of the Newburgh Water Department and to personnel of the Water Supply Division of the New York State Health Department through whose courtesy the data were made available.

### References

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2. *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes*. APHA, AWWA, & FSIWA, New York (9th ed., 1946; 10th ed., 1955).

\* All tables and figures on pp. 514-516.

(Tables 1-3 and Fig. 1-6 follow on pp. 514-516.)

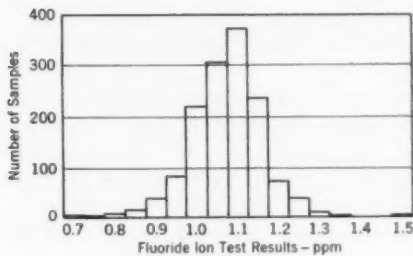


Fig. 1.

Fig. 1. Graphic Representation of Frequency Distribution of 1,388 Fluoride Ion Test Results at Newburgh, N.Y.

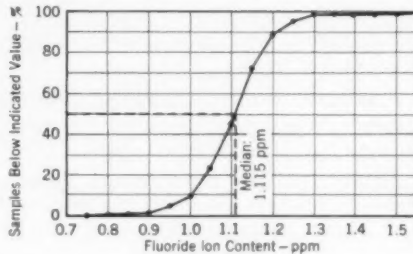


Fig. 2.

Samples from the Newburgh water distribution system were analyzed at the water works laboratory and covered the period June 1950-June 1952.

Fig. 2. Curve of the Cumulative Distribution for the Same Test Results Used in Fig. 1.

TABLE 1  
Distribution of Fluoride Ion Test Results  
at Newburgh, N.Y.\*

Fluoride Ion Content—ppm	No. of Samples	Cumulative No. of Samples	Cumulative Samples—%
0.70	2	2	0.14
0.75	1	3	0.22
0.80	6	9	0.65
0.85	13	22	1.59
0.90	37	59	4.25
0.95	80	139	10.01
1.00	220	359	25.36
1.05	306	665	47.91
1.10	374	1,039	74.86
1.15	235	1,274	91.79
1.20	69	1,343	96.76
1.25	36	1,379	99.35
1.30	7	1,386	99.86
1.35	1	1,387	99.93
1.40	0	1,387	99.93
1.45	0	1,387	99.93
1.50	1	1,388	100.00

Total Samples: 1,388      Median: 1.105 ppm  
Mean: 1.07 ppm      Standard Deviation: 0.084 ppm

\* Analyses by Newburgh water treatment plant laboratory. Period covered: Jun. 1950-Jun. 1952.

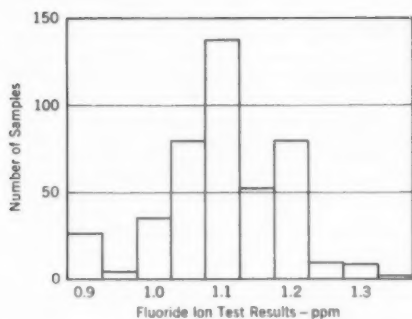


Fig. 3.

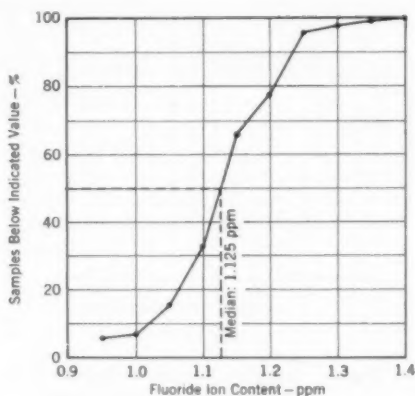


Fig. 4.

Fig. 3. Graphic Representation of Frequency Distribution of 432 Fluoride Ion Test Results at Newburgh, N.Y.

Samples from the Newburgh water distribution system were analyzed at the state health department laboratory and covered the period June 1950-June 1952.

Fig. 4. Curve of the Cumulative Distribution for the Same Test Results Used in Fig. 3.

TABLE 2  
Distribution of Fluoride Ion Test Results  
at Newburgh, N.Y.\*

Fluoride Ion Content—ppm	No. of Samples	Cumulative No. of Samples	Cumulative Samples—%
0.90	27	27	6.25
0.95	4	31	7.18
1.00	35	66	15.28
1.05	79	145	33.56
1.10	138	283	65.51
1.15	52	335	77.55
1.20	79	414	95.83
1.25	9	423	97.92
1.30	8	431	99.77
1.35	1	432	100.00

Total Samples: 432    Median: 1.125 ppm  
Mean: 1.10 ppm    Standard Deviation: 0.087 ppm

\* Analyses by state health department laboratories. Period covered: Jun. 1950-Jun. 1952.

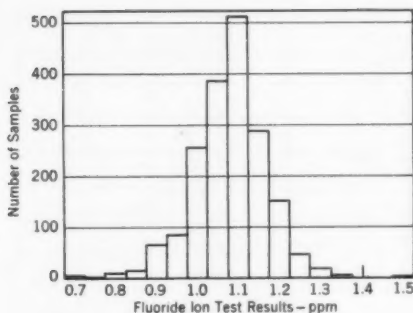


Fig. 5.

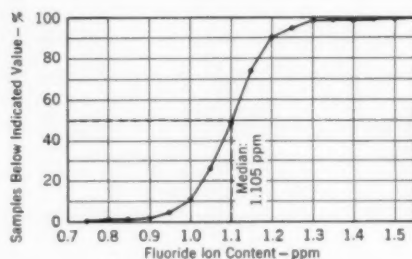


Fig. 6.

Fig. 5. Graphic Representation of Frequency Distribution of 1,820 Fluoride Ion Test Results at Newburgh, N.Y.

Samples from the Newburgh water distribution system were analyzed at the water works laboratory and the laboratory of the state health department and covered the period June 1950-June 1952.

Fig. 6. Curve of the Cumulative Distribution for the Same Test Results Used in Fig. 5.

TABLE 3  
Distribution of Fluoride Ion Test Results  
at Newburgh, N.Y.\*

Fluoride Ion Content—ppm	No. of Samples	Cumulative No. of Samples	Cumulative Samples—%
0.70	2	2	0.11
0.75	1	3	0.17
0.80	6	9	0.49
0.85	13	22	1.21
0.90	64	86	4.73
0.95	84	170	9.35
1.00	255	425	23.35
1.05	385	810	44.50
1.10	512	1,322	72.75
1.15	287	1,609	88.4
1.20	148	1,757	96.6
1.25	45	1,802	99.1
1.30	15	1,817	99.6
1.35	2	1,819	99.9
1.40	0	1,819	99.9
1.45	0	1,819	99.9
1.50	1	1,820	100.0

Total Samples: 1,820    Median: 1.115 ppm  
Mean: 1.08 ppm    Standard Deviation: 0.085 ppm

\* Analyses by Newburgh plant laboratory and state health department laboratory. Period covered: Jun. 1950-Jun. 1952.

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## Pipeline Network Analysis by Electronic Digital Computer

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Lyle N. Hoag and Gerald Weinberg

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*A contribution to the Journal by Lyle N. Hoag, Engr., Brown and Caldwell, San Francisco, Calif., and Gerald Weinberg, Applied Science Repr., Service Bureau Corp., Los Angeles, Calif.*

THE analysis of flow in pressure conduit networks, such as municipal water distribution systems, has occupied the attention of several investigators beginning with the well-known study by Hardy Cross (1) in 1936. Prior to development by Cross of a rational relaxation technique, pipeline network problems could be solved only by a perplexing and time-consuming trial and error process, which necessitated the satisfaction of the two basic hydraulic principles applicable to network flow:

$$\sum Q = 0 \dots \dots \dots (1)$$

$$\sum h = 0 \dots \dots \dots (2)$$

The first condition states that the flow in a network system must be balanced at every junction point, and the second that the algebraic sum of the head losses around any closed circuit must be zero.

Because the head loss in any component of a hydraulic system varies nonlinearly with the rate of flow, it is evident that the network system cannot be described by a set of simultaneous linear equations. Accordingly, the numerous numeric techniques which have been developed to deal with simultaneous linear equations are of no value.

Several methods of varying accuracy and complexity are now available to the analyst for solving network prob-

lems. This paper discusses a method of utilizing the extreme speed and accuracy of commercially available electronic digital computers as applied to a modification of the classical numeric relaxation technique. The value of this new method is best appraised by a comparison with present analytical techniques, which include: [1] the method of sections; [2] the Hardy Cross relaxation technique; [3] the linear approximation method; and [4] the electrical analogy network analyzer.

### Method of Sections

In the sense used here, the method of sections is not a true analytical technique but is a very valuable tool in that it makes possible a very rapid approximate evaluation of network systems. Following the determination of demands on a system, the network is divided by arbitrarily drawn sections, and the assumption is made that the hydraulic gradient is the same for all pipes crossing the section. With the properties of the pipes and the total flow across the section known, it is easy to calculate the actual hydraulic gradient at the section chosen. Overall deficiencies can be spotted and the effect of design changes quickly evaluated. This method is valuable also in evaluating the effect of a required fire flow on local pressure conditions. It is not, however, satisfactory for evalu-

ating hydraulic conditions in a system with multiple constant-head inputs such as is found in reservoirs.

### Hardy Cross Technique

The Hardy Cross relaxation technique is an iterative procedure which involves the successive application of "optimum" corrections to the flow in

the general expression for head loss in hydraulic flow which may be indicated by a simplified derivation:

$$h_i = K_i Q_i^n \dots \dots \dots (3)$$

where  $h$  is head loss;  $K$  is a function of the flow and pipeline properties, here considered to be a constant;  $Q$  is rate of flow; and  $n$  is a function of  $Q$

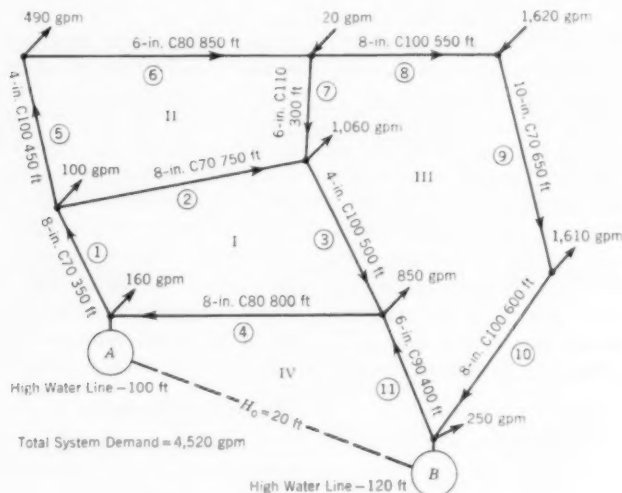


Fig. 1. Sample Network Problem

The problem involves two reservoirs—A and B—at known elevations, and two constant rate inputs. The tabulation of the solution is given in Table 1.

each line of closed pipeline loops as exemplified by the simple problem shown in Fig. 1. In this technique, the initial values of the flows are assumed by the analyst and must satisfy Eq 1. Because any correction is applied to all lines in a particular loop, Eq 1 remains satisfied throughout the calculations. The magnitude and sign of the correction to be applied to any loop are governed by the magnitude of the deviation of that loop from Eq 2. The "differential correction" follows from

which varies from 1.0 to 2.0, here considered to be a constant. If

$$dh_i = nK_i Q_i^{n-1} dQ_i \dots \dots \dots (4)$$

then

$$dQ_i = \frac{dh_i}{nK_i Q_i^{n-1}} \dots \dots \dots (5)$$

so

$$\Delta Q \approx \frac{\sum K_i Q_i^n}{\sum nK_i Q_i^{n-1}} \dots \dots \dots (6)$$

It is common in water works engineering to use the well-known Hazen-

Williams pipe flow formula—an empirical attempt to achieve accuracy over a fairly wide range of flows while using constant values for  $K$  and  $n$ . This equation takes the form

$$h = KQ^{1.85} \dots \dots \dots (7)$$

The Hardy Cross method can be used to achieve any desired accuracy within the limit of accuracy of the values for  $K$ , a function of the pipe properties. While it represents a vast improvement compared to the uncontrolled trial and error method, this method is quite time-consuming for larger networks. For example, a network including 100 lines may require several weeks of continuous hand calculation to achieve an acceptable order of accuracy.

### Linear Approximation

A method of determining successive approximations by the solution of a set of simultaneous linear equations, which describe the hydraulic system approximately for small changes in  $Q$ , was developed by McIlroy (2). This method, while achieving significant savings in time compared to the Hardy Cross method, is less straightforward and becomes extremely cumbersome when used with a large number of unknowns.

### Network Analyzer

The possibility of using the analogy between electrical networks and hydraulic networks was first discussed by Camp and Hazen (3) who used, in effect, a successive approximation method with a linear electrical circuit. This required changing the resistance of each branch of the circuit several times until the potential drop and current therein corresponded to the known relationship between head loss and flow in each analogous pipe. With the per-

fection by McIlroy (4) of nonlinear resistance elements which have characteristics described by the electrical equivalent of Eq 3, the electrical analog computer became capable of solving hydraulic network problems directly.

Direct-reading network analyzers are now manufactured commercially and several installations are available to engineers in the United States on a fee basis. These analyzers have two disadvantages:

1. The solution of a problem requires the physical assembling of the analogous electrical circuit. For a large network, this operation not only takes considerable time but dictates that a series of solutions for different flow conditions be run rapidly in order to avoid tying up the machine for an extended period. Although changes and additions to the electrical method can be made quite rapidly, the designer often is unable to study each solution thoroughly before trying the next.

2. Currently produced electrical analyzers are often not capable of satisfactory accuracy for problems which permit a close determination of the physical properties of conduits. Although the electrical circuit follows Kirchhoff's laws precisely (the electrical equivalents of Eq 1 and 2), data given in the literature (4) indicate that the errors in some individual lines often approach 20 per cent. Nonlinear resistance elements, moreover, are produced in finite increments of  $K$  values, thus also producing some inherent error. In most water system problems, however, these errors are of secondary significance.

### The Digital Computer

In an attempt both to overcome the already noted disadvantages and to avoid the need for travel to an available

electrical network analyzer, a program was developed for the solution of network problems by an electronic digital computer or "data processing machine," using the numeric relaxation technique. The particular machine used for this purpose was of the magnetic drum, stored program type which receives its instructions and data from

manipulations, a lengthy step by step "program" of instructions is required to solve a complex problem. This, however, poses no problem as computations can be made at a rate of more than 200,000 per hour. Hence, long and tedious network problems can be solved rapidly with any desired degree of precision.

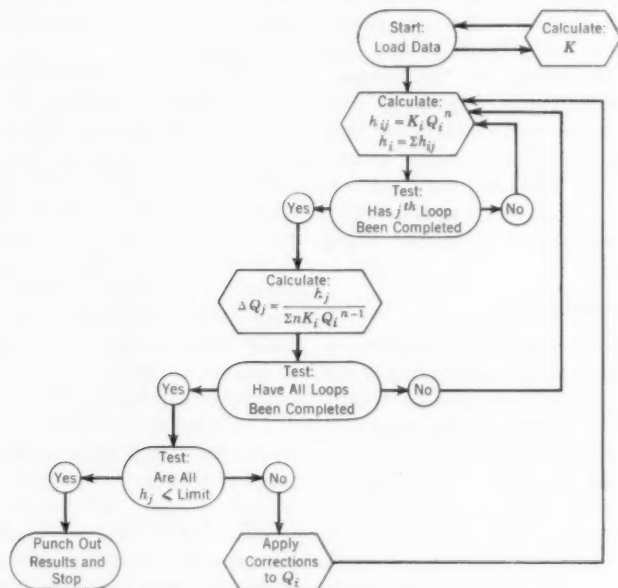


Fig. 2. Programming Flow Chart for Electronic Digital Computer

*In the simplified chart for the solution of hydraulic network problems each calculation step represents many arithmetic manipulations.*

punched cards through an automatic card "reading" unit.

In the digital computer, individual instructions and data are stored as magnetized spots located on a revolving drum and actual arithmetic computation takes place in "accumulator" components. Because the machine is basically capable of only the simplest arithmetic

The basic Hardy Cross iterative technique provides the most desirable approach to the network problem for computer solution. This is because it is the easiest of the numeric techniques to program and because it can be modified readily to accelerate convergence. The first application of this digital computer technique was to the water distri-

bution system of the city of Palo Alto, Calif. This system was being studied at the time and was selected because field measurements had been made to determine values of the friction coefficient  $C$  in the Hazen-Williams pipeflow formula.

The Hazen-Williams formula was chosen as it is the one most commonly employed by water works engineers. In the program developed the flow equation was used in the form:

$$h = K' Q^{1.85} \dots \dots \dots (8)$$

with

$$K' = \frac{10.43L}{C^{1.85} D^{4.87}} \dots \dots \dots (9)$$

TABLE 1  
Tabulation of Results for Problem  
in Fig. 1 \*

Line	Rate of Flow gpm	K, Function of Pipeline Characteristic	Head Loss ft
1	600.6	0.000056185	7.76
2	335.9	0.000120397	5.67
3	118.2 -	0.001213461	8.28 -
4	341.2 -	0.000100315	4.86 -
5	164.6	0.001092115	13.77
6	325.3 -	0.000446000	19.81 -
7	605.7	0.000084400	11.84
8	911.0 -	0.000045600	13.62 -
9	708.9	0.000039700	7.46
10	901.0 -	0.000049700	14.55 -
11	627.0	0.000165000	24.69

\* Computer time required for solution: 1.4 min.

where  $h$  is head loss, in feet;  $Q$ , rate of flow, in gallons per minute;  $L$ , length of pipe, in feet;  $C$ , the Hazen-Williams friction coefficient; and  $D$ , the diameter of pipe, in inches.

The choice of units is not important but those chosen were felt to be of maximum convenience in the problem at hand. In practice, the values of  $C$ ,  $D$  and  $L$  are tabulated for each pipeline

and are fed into the machine on punched cards through the card read-write unit. The machine then calculates and stores the values of  $K'$  while the next card is being read.

Calculations of  $h$  involve the evaluation of a fractional exponent of  $Q$  by numeric techniques. Of the several ways of performing this operation, the one selected requires the evaluation of approximation expressions for the logarithm and exponential. The logarithm of  $Q$  is multiplied by 0.85 and the product is evaluated as an exponential to yield the value of  $Q^{0.85}$ . Although this method may seem cumbersome, the machine can evaluate the power of a typical value of  $Q$  in about 0.5 sec.

The network calculations follow the steps in the simplified programming flow chart shown in Fig. 2. Because these calculations involve the performance of an identical set of arithmetic manipulations for each of several lines of a network loop and for each of many loops, their programming can be greatly simplified by using a technique known as "looping." Looping enables the machine to apply a series of calculations to a large set of data by sensing the completion of the series of arithmetic steps and instructing the machine to return to the first step of the series automatically for processing of the new data. Following the completion of a repetitive series of calculations on a particular pipeline, the computer automatically proceeds to the next appropriate line, and the set of calculations is repeated with the new data for that line. Criteria must be established and tests must be made to tell the machine when it has completed the calculations on all of the applicable lines or loops and thus should proceed to the next step shown in the flow chart. These simple tests consume only milliseconds.

In similar fashion, a criterion must be established for stopping the iterative procedure when the desired accuracy has been achieved. This is accomplished by examining the absolute magnitude of the unbalanced head loss,  $\Sigma h$ , around each loop at the end of every iteration. When all such "residuals" are less in magnitude than a value the designer has set, the calculations stop and the answers are punched out

$Q$ , in an exterior line affected by the corrections of one loop only, will be the area under the curve beyond the point at which the calculations are stopped. For example, a limit of 10 gpm placed on  $\Delta Q$  might result in errors as high as 100 gpm in some lines. It should be noted again, however, that any desired accuracy can be achieved by the appropriate setting of the magnitude of the limiting criterion.

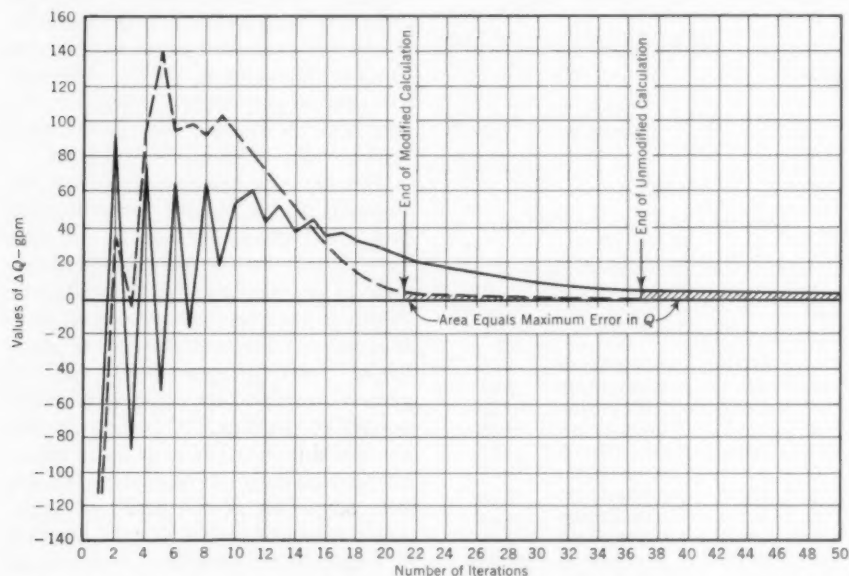


Fig. 3. Curves Showing Typical Fluctuation of Flow Rate Corrections for Solutions With Modified and Unmodified Programs

through the read-write unit, ready for automatic listing as shown in Table 1.

Using a limit on  $\Sigma h$  as the criterion for completion is more rational than placing a limit on the magnitude of the correction,  $\Delta Q$ , as it has been found that the relationship between the value of  $\Delta Q$  and the number of iterations or cycles has a form somewhat like that shown by the solid line in Fig. 3. It can be seen that the error in flow rate,

Minor modifications have been devised for dampening the fluctuations shown in Fig. 3 and speeding convergence to the final answer. When the value of the correction is oscillating violently as revealed by the alternation of the sign of  $\Delta Q$ , a factor of 0.5 is applied to the magnitude of the correction to be applied. A second shortcut involves ignoring the loops which are close to convergence on alternative

iterations, thus concentrating on those portions of the system furthest out of balance. These modifications tend to produce a  $\Delta Q$  function change as shown by the dashed line in Fig. 3.

### Palo Alto Experience

For the analysis of the Palo Alto water distribution system, a network map was prepared which neglected all 4-in. lines and some 6-in. lines. Some 6- and 8-in. lines were combined with adjacent larger lines by rapid equivalent pipe calculations, resulting in a network containing 38 loops with 103 lines.

The Palo Alto system analyzed includes nine wells with rates of input assumed to be constant, and four aqueduct connections operating at a constant head and a variable rate of input. The latter added three "equivalent loops" to the problem, each with a constant, known residual or unbalanced head. In the program, these residuals were added to the  $\Sigma h$  calculations for the appropriate loops in each iteration, causing  $\Sigma h$  to converge to zero in the standard manner.

In a large network it is almost impossible to choose initial values of flow (satisfying Eq 1) which are of the correct sign and order of magnitude. With quite poor assumed initial values, the Palo Alto system required 50 min. of machine time, and 37 iterations to reach the limit of 1.0 ft maximum head imbalance. Subsequent solutions of the same system for various hydraulic conditions took an average of about 17 min. of machine time. This was because the starting values of  $Q$  were much closer to the final values.

For problems with relatively minor hydraulic changes, the answers from the preceding solution may be used directly as initial values of flow rate.

This shortcut is facilitated by having the punchout cards of the same form as the input cards. If pipeline changes or additions are indicated by the answers to a problem, it is usually necessary only to change a few digits on the appropriate output cards and rerun the problem using the modified output deck of cards as the new input deck. In this case, convergence is very rapid and may be obtained in as little as 5 per cent of the time required when starting from scratch.

A total of eight different solutions was performed for the Palo Alto system, requiring about 2½ hr of machine time and involving a cost of perhaps \$500 including keypunching, machine rental, and engineer's tabulation and checking time.

The procedure developed has thus far been used only on water distribution systems and only with the Hazen-Williams formula for friction losses. This procedure, however, is quite general and, with minor modifications, should be adaptable to any fluid flow network, gas, or liquid. In some cases it is feasible, and certainly more desirable, to use the rational and more accurate Darcy-Weissbach flow equation

$$h = f \frac{L}{D} \frac{V^2}{2g} \dots \dots \dots (12)$$

where  $f$ , the friction coefficient, varies with  $Q$ . If values of  $f$  are known, it is usually sufficiently accurate to set up an empirical relationship between  $f$  and  $Q$ , applicable over the range of interest. In water works problems a simple relationship of the form  $f = kQ^m$  can be evaluated to give very good accuracy. Using this equation, the value of  $f$  would be calculated from the value of  $Q$  in the previous iteration. This procedure would take little longer than

that employing the Hazen-Williams formula because only one fractional exponent need be evaluated in either case for each head loss calculation.

An important problem in many hydraulic networks with pumped inputs is that of varying the input rate with head as indicated by the pump characteristic curve. This added complication could be handled by the digital computer method, although several program modifications would be required. As the input rate changed, the satisfaction of Eq 1 would have to be restored by making corresponding changes in  $Q$  in appropriate lines of the network. A computer of the type used for the Palo Alto study is capable of making linear interpolations automatically between values of the argument of a function which is stored on its magnetic drum in the form of a table of values of that function. It would thus be necessary to store in the computer only a few values of  $h$  and  $Q$  from each of the known pump characteristic curves.

It should be noted that the modifications and program additions discussed above would consume space on the 2,000 "word" or cell magnetic drum and would thus reduce the capacity of this machine below its present level of a 100-loop network. It may sometimes be desirable to employ larger capacity, though more expensive, computers.

### Summary

The method which has been developed for the solution of pipeline net-

work problems with the aid of electronic digital computers uses the basic iterative procedure originally developed by Hardy Cross. This method appears to be more accurate and less costly than the other currently available analytic methods for a large class of network problems. Minor program modifications and additions would enable the digital computer to solve virtually any problem encountered in fluid network flows. One of the principal advantages is the ready availability of such computers in nearly every metropolitan area and university in the United States.

### Acknowledgments

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## Meeting Increasing Demands in San Diego County, Calif.

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—Paul Beermann and Richard S. Holmgren—

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*A paper presented on Oct. 24, 1956, at the California Section Meeting, San Diego, Calif., by Paul Beermann, Director, Water Dept., city of San Diego, Calif., and Richard S. Holmgren, Gen. Mgr. & Chief Engr., San Diego County Water Authority, Calif.*

**S**AN Diego County is the southernmost county in California, lying adjacent to the Mexican border and extending from the Pacific Ocean to the desert areas in Imperial County. It has a semiarid climate with rainfall ranging from approximately 10 in. along the coast, to as much as 40 in. in the higher altitudes of the Laguna Mountains which parallel the coast approximately 40 miles inland. In the average year, 74 per cent of all rainfall occurs in the December–March period. Of the remaining 26 per cent practically none falls in the June–September period. The flow in most county streams is intermittent and virtually nonexistent during the summer months. Floods have generally occurred every 10 or 11 years, and storage has had to be constructed to span the long drought periods. In spite of the obstacles resulting from an insufficient local water supply, the population in the county has steadily increased to the present total of approximately 800,000 persons. Agriculture in the county has expanded continually so that, in 1955, farmers received for their products an all-time high of \$92,849,830. Among the products were field and truck crops, dairy products, livestock, fruits and nuts, and miscellaneous crops. In dollar value of June 1955 agricultural production, San Diego ranked approximately eighteenth among the 3,068 counties of the United States.

### Local Developments

Most of the available local sources of water within San Diego County have been developed. As no extensive underground basins exist in the county, the major local developments are large storage reservoirs constructed on the major streams in the foothills area to impound the runoff from the mountain areas. The stored water is then made available uniformly throughout the year to meet demands. The total of all developed water supplies within the county—including those few supplies obtained from underground basins—is estimated to produce a safe yield of approximately 95,000 acre-ft per year.

The largest developments of local water, in size and number of reservoirs, have been made by the city of San Diego. The city's basic water supply (a safe yield estimated at approximately 46,000 acre-ft per year), is obtained from eight impounding reservoirs which have a combined capacity of 420,900 acre-ft and which are located in the Tijuana, San Diego, and San Dieguito river basins. The only other major systems are two reservoirs of the California Water and Telephone company on the Sweetwater River, and Henshaw Reservoir of the Vista Irrigation District on the San Luis Rey River. These yield approximately 10,000 acre-ft per year. Limited underground sources are used in the Oceanside–



Fig. 1. Constituent Areas of the San Diego County Water Authority

Carlsbad area, the Fallbrook and the Rainbow districts from the San Luis Rey River valley, and the Rio district in the San Diego River valley.

As far back as 1916, there was a recognition that water would have to be imported from the Colorado River or elsewhere to accommodate future growth. In April 1926 the San Diego city council filed for 112,000 acre-ft per year (155 cfs) for its use from the Colorado River. Had the water right issue been foreseen, a much larger appropriation would undoubtedly have been requested.

During the war years the population grew by leaps and bounds. San Diego city increased from 202,000 in 1940, to more than 362,000 in 1946.

Because of the rapidly falling water levels in San Diego, the US Navy, which has large facilities in the county, began the construction of an aqueduct to be linked to the Metropolitan Water District Colorado River Aqueduct system. The San Diego Aqueduct was still under construction at the end of the war when the Navy decided to halt work. The city of San Diego agreed to pay for the aqueduct if it were completed.

The San Diego County Water Authority was organized under the sponsorship of the city of San Diego by a group of nine agencies engaged in the distribution of water, for the purpose of importing Colorado River water. The number of authority member agencies now total sixteen: four cities, five irrigation districts, one public utility district, and six municipal water districts. The area under the authority's jurisdiction, totaling about 374,000 acres, is shown in Fig. 1.

When the city of San Diego filed for water from the Colorado River, transportation to San Diego County could be arranged either by building facilities over the Laguna Mountains to bring

water from Imperial Valley, or through the Metropolitan Water District system. When the US Navy was constructing the San Diego Aqueduct, a decision was made to join the Metropolitan Water District, so that the San Diego rights to Colorado River water were merged with those of the Metropolitan Water District. The authority thus became a constituent area of the Metropolitan Water District on Dec. 17, 1946, and, as such, now receives Colorado River water from the district's San Diego feeder, at a point near the San Luis Rey River, 6 miles south of the San Diego County northern line.

The first Colorado River water reached the San Diego area in 1947. It was hoped that this would meet the demand for some time. With continuing growth, however, it became evident that a second barrel to the aqueduct was necessary. The second barrel of the first aqueduct was completed in October 1954.

The Metropolitan Water District delivers water to the San Diego County Water Authority at the San Luis Rey River. The San Diego County Water Authority then delivers water to the agencies along the line and to the San Vicente Reservoir owned by the city of San Diego. Two branchlines—one extending from the aqueduct at Rainbow to the city of Oceanside, and the other extending from the aqueduct (just before it empties into San Vicente Reservoir) to the Sweetwater Reservoir—are also a part of the system. All member agencies take delivery of water from metered service outlets along the aqueduct and branchlines. The Metropolitan Water District delivers approximately 197 cfs, or 140,000 acre-ft per year, to the authority through its feeder. The authority does not treat the water, but does chlorinate the flow in the aqueduct during the summer months to prevent bacterial growth in

the pipes. Experience has indicated a decrease in carrying capacity unless the aqueduct is chlorinated during the summer months. Good results have been obtained in maintaining aqueduct capacity by superchlorination for a period of 6 hr, twice a week. Other than the chlorine treatment, the authority delivers raw Colorado River water to its agencies as received from the metropolitan district. The city of San Diego filters all water before delivery to consumers.

### **Short Supplies**

The combined annual water production of the authority agencies for the past 20 years has increased from approximately 30,000 acre-ft of water to approximately 155,000 acre-ft—a 500-per cent increase. In the same period, supply available to agencies within the area increased from approximately 42,000 acre-ft per year (entirely local) to 230,000 acre-ft per year (developed local supply and Colorado River supply imported by the authority). The amount of imported water is estimated to be 140,000 acre-ft per year—the capacity of the metropolitan feeder.

Substantially less than normal rainfall in 9 of the past 11 years has resulted in drought conditions in the San Diego area. The average 1955–56 rainfall was only 4.5 in. or 45 per cent of the 10.8 in. yearly average rainfall of the past 100 years of record. Because of this condition, it has been impossible to replenish the local supplies which were seriously depleted by the military activities in the area during World War II.

When the San Diego Aqueduct was brought to its full capacity in October 1954 by the construction of the so-called second barrel, the deficiency in local supply, resulting from the 10 years of drought conditions, placed a greater de-

mand on the authority system than had been anticipated.

At this period, the Metropolitan Water District, which had offered annexation generally to cities only, changed its policy to permit entry into the district of practically all who desired to annex, with no requirements of having a basic water supply. As a result of this policy, larger annexation of dry lands was made to the San Diego County Water Authority as well as the Metropolitan Water District.

The inadequacy of the aqueduct under this revised policy, simultaneously with the dry years, became apparent early in 1954, and the water authority proceeded, with the aid of an engineering study, to determine the probable ultimate authority area and a general plan of a system needed to supply water efficiently to an enlarged service area.

The results of the study were contained in a 1955 report (1) which stated that the probable ultimate area of the authority might be approximately 820,000 acres, and the water requirements to meet the supplemental needs of this area were estimated at approximately 700,000 acre-ft, or about five times the capacity of Metropolitan Water District's present San Diego feeder.

The study also showed the requirements in the near future, which were even more startling. Ample rainfall and a replenishment of developed local supplies being assumed, it was apparent that the present feeder capacity would be insufficient to meet the supplemental needs of the area by 1959, if the present rate of growth were to continue. Since the report was written, the General Dynamics Corporation has begun the construction of a plant to produce guided missiles and an atomic research laboratory in the city of San Diego. These

additions will create a substantial and rapid increase in population within the has announced a plant to provide for the expansion of Scripps Institution of Oceanography in San Diego. Under the plan engineers and scientists will be trained for placement in the atomic and aeronautical activities of the area. A large number of smaller plants, principally in the electronics field, are also springing up in the area. The developments mentioned indicate that the present rapid growth in population will continue and other substantial water supplies will be needed as soon as they can be constructed.

The only source of water which can be tapped soon enough to meet the needs of the continued rapid growth of the area, is "interim surplus" Colorado River water from Metropolitan Water District's system to which the authority has a right as a constituent member. This right will exist until such time as other areas within the Metropolitan Water District exercise their right to purchase their preferential right, or unless other conditions place limitations on the available main Colorado River water supply. An aqueduct, designed for 500 cfs and terminating at the Lower Otay Reservoir of the city of San Diego, would cost, it is estimated, approximately \$50,000,000. The proposed and the present aqueducts, if water were available, could supply the area with approximately 500,000 acre-ft annually—sufficient to meet the estimated supplemental needs to 1980.

A board of consulting engineers, consisting of Raymond Hill, Carl Rankin, and John S. Longwell, generally concurred in the authority report but questioned the long-term availability of water from the Colorado River to supply this second aqueduct, especially if the remaining Metropolitan Water District area also continues to grow.

### State Studies

The state engineer, in a report on the Feather River Project (2), included as part of that project an aqueduct located at el 3,500, extending from San Bernardino south through San Diego County, terminating at Barrett Reservoir—an impounding reservoir of the city of San Diego on Cottonwood Creek (a branch of the Tijuana River).

When the immediate need for construction of a second San Diego aqueduct arose, it was suggested that, inasmuch as water would not be available for 10–15 years at the higher level proposed in the Feather River Project report, the proposed second San Diego aqueduct might be substituted in the project for the higher-level line, and water be temporarily taken by gravity from the available surplus in Metropolitan Water District's Colorado River Aqueduct.

The state legislature meeting in 1956 acted on this proposal and directed the State Division of Water Resources (now the Department of Water Resources) to study means by which Feather River water could best be delivered into San Diego County. The legislature appropriated \$200,000 for the study.

Studies by the department began in July 1956, when money became available, and have been carried forward actively ever since. The authority has made available to the department all the basic computations and profiles produced in its study and has assisted in obtaining additional data. The department is concentrating primarily on the economic features of the plan and is reviewing the location proposed by the authority. No report has yet been released, but it is expected that recommendations as to size and location of a second aqueduct will be available before the end of the year.

### Immediate Problems

As of Oct. 31, 1956, the amount of water in surface storage reservoirs of authority member agencies totaled approximately 70,000 acre-ft, or approximately enough water for 3 months, allowing for evaporation losses in the reservoirs. Subsurface supplies have been practically depleted for some time.

If drought conditions continue, the requirements for the water year (Nov. 1, 1956–Oct. 31, 1957), based on estimates of need submitted by each of the member agencies, will not be met by water from available local supplies and supplementary water from the authority system. The needs, which include the storage of a minimum of 50,000 acre-ft for emergency while using all other stored water, will give rise to an estimated deficiency of 24,000 acre-ft outside the city areas. In the following year (1957–1958), the deficiency will increase to 50,000 acre-ft. The city of San Diego's entitlement is adequate to provide for its needs at present.

Studies have been made of temporary emergency works which might be installed to bring in additional water from the Metropolitan Water District's Colorado River Aqueduct in time to meet the expected summer 1957 deficiency. Temporary works have included the installation of pumping units on the existing aqueduct and the placing of an independent emergency pipeline, as inexpensive as possible, with a pumping unit. The first proposals failed to secure approval of the US Reclamation Service which engineered the aqueduct.

The Metropolitan Water District stated it could not provide the emergency line and would not make additional water available if the line were constructed by others. The district has since authorized the preparation of

plans and specifications for the upper end of this aqueduct.

### Summary

An adequate water supply for San Diego County has been one of the major problems ever since the padres constructed works to divert water from the San Diego River to irrigate the farmlands in the river bottom south of the San Diego de Alcala Mission.

In the 1891–1903 period, drought conditions conflicted with developments, and all reservoirs became dry. Wells were sunk in the exposed reservoir bottoms to meet the needs of the area.

In the present period of drought, supplies have been sufficient to meet needs, but if the drought continues, some county areas will suffer seriously.

The construction of a line from the Metropolitan Water District system, using "interim surplus" Colorado River water, can be completed by the summer of 1959. Water in the interim will be available depending on the growth and water demands of the other Metropolitan Water District agencies and supplemented, it is hoped, by rainfall.

Salt water reclamation, cloud seeding, and other schemes of that type offer no promise of long-term solution. The only practical long-term answer is contained in the monumental California Water Plan discussed in a previous *Journal* (3).

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## Growth and Conversion of Water Systems in San Diego County, Calif.

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—Linden R. Burzell—

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*A paper presented on Oct. 26, 1956, at the California Section Meeting, San Diego, Calif., by Linden R. Burzell, Mgr., Vista Irrigation Dist., Vista, Calif.*

**T**HE growth of Southern California since World War II has been given wide publicity. The chambers of commerce and statisticians are predicting that this growth will continue.

Every community has had to take part in providing homes and jobs in one of the world's greatest migrations of people. The largest percentage increase in population has, reputedly, been in San Diego County. No community has been immune to this growth—from the seashore to the mountains and even into the deserts—the population has increased. Where there has been adequate planning, the growth has been orderly. Where there has been too little planning, the growth has caused confusion.

In San Diego County, the impact on water companies has caused many hardships because essentially all local water sources had been developed before World War II. San Diego County had very little ground water so that no resort could be made to over-drawing of ground water supplies as in some other parts of the state.

### Growth of the Shortage

This influx of population had to settle in those communities and districts where there was available water. Much of San Diego County's rolling hills thus became view lots too valuable for agriculture. These areas have

been sold and subdivided so that there are homes where before there were specialty crops such as citrus and avocado.

When the community has changed its character from agricultural to residential and industrial, it has been the least adversely affected because the whole community has changed. All want municipal improvements, and these includes the highest quality water. In many areas the change is slower. People settle on small ranches, chicken farms, and subdivisions. Thus the gradual division of large agricultural holdings brings farmers, irrigators, and plain residents together. There is little or no industry with its higher assessed values; only small tracts mixed into a basically agricultural community. How has this affected water companies?

Most of the northern half of San Diego County was originally developed for agricultural purposes. The early twentieth century farmers built their water systems to supply irrigation water. The water supply came from shallow wells or large surface reservoirs. A typical development provided water at limited pressure for sprinkler service and primarily gravity water for furrow irrigation and storage was adequate to regulate irrigation flows only. Distribution system pipeline design was based on 24-hr irrigation, ordered water on schedules, and no pressure at

high points. Mains and transmission facilities were either lightly reinforced concrete pipe or concrete-lined canals. Pumps and pipelines were not duplicated and were not in parallel, so that major repairs to the system meant that all or part of the system would be out of water. The systems were operated manually by an operator called a *sanjero*.

This system of adequate irrigation at reasonable costs was entirely satisfactory for the farmers. During the 1900-1945 period, communities like Escondido, Fallbrook, Vista, and Rancho Santa Fe expanded and developed into thriving agricultural communities. The avocado and citrus industry grew and the entire water supply was put to use—in fact, utilized beyond same limits, until each of these major water using areas had to turn to the Metropolitan Water District and the San Diego County Water Authority for Colorado River water as a supplementary supply.

Today in San Diego County, the farmer and his irrigator still exist. The organizations that operate the water systems are, for the most part, irrigation districts or mutual water companies, controlled, for the time being, by the irrigators. This is only fair for irrigation water makes up 80-90 per cent of water sales. In Vista, for example, the Vista Irrigation District today sells more water than cities as large as Santa Monica or Beverly Hills, although it has a far smaller population.

### **Approach to the Problem**

Management must operate these systems in the fairest possible way and provide the best service possible to each class of consumer. The economy is such that the basic components of the original systems must be utilized. This philosophy has been practiced throughout Southern California where

engineers and operators have worked out simple, inexpensive, practical schemes to convert important parts of their system from irrigation works to dual purpose systems that can serve domestic consumers quite adequately and safely, but not always up to the best standards of the industry.

One of the greatest savings in capital outlay has probably been the conversion of gravity pipelines to satisfactory domestic water mains. Traditionally, the gravity pipelines in Southern California are made of unreinforced or lightly reinforced concrete pipelines designed to flow partially full. When an irrigator wanted water he would order it from the company. The water turned into the line was diverted over the customer's weir. If the water was not being tapped in such a manner, it would run to the end of the line and be wasted. Gradually, for operational and conservation purposes, regulating reservoirs were added at the end of the pipelines so that domestic flows could be kept flowing at all times for the occasional farmer that wanted domestic water. Where grades permit, today, enterprising operators have closed the end of some gravity lines and raised the standpipes along the pipeline, so that, by using a float valve at the inlet, the pipe can be kept full at all times and consumers can then have service at will with a head on the line up to 8 or 10 ft. Under this type of operation, weirs can be removed and conventional meters installed. In the Escondido Mutual Water Company's system this technique has been further perfected on a 24-in. pipeline by installing float controlled butterfly valves in the pipeline every 2,000 ft or so. In this 8,000-ft section of pipe, all customers are now on demand service at a saving of approximately \$100,000 capital investment. Probably 80 per cent of the

water that flows through the main is for irrigation. The farms along that pipeline could not have afforded to pay \$1,000 each for pressure water.

In the Vista system several miles of this same type of pipe are considered as part of the ultimate system. Well constructed concrete pipe with its inherent low maintenance cost still has a part in the facilities.

The most serious deficiencies in irrigation water systems tending to make impractical or too costly the conversion into suitable domestic water facilities are those dealing with water quality and contamination. As soon as domestic water is provided, the entire system must come up to the standards of the state health department. There are many ways to accomplish the results without building a whole new system.

### **Conversion of Open Canals**

Open canals and flumes present particularly difficult problems. Vista had 12 miles of open, rectangular, gunited box flume that traversed an area that was gradually being covered with small farms and home sites. Caddis flies infested the flume in the summer months and restricted water flows. Water treatment with chlorine had very little value because of the rapid dissipation in sunlight. A reinforced concrete gunite arch cover was built over the flume at very low cost, thus solving these and other problems. Today, children no longer bathe in the canal, carrying capacity remains at design capacity, and the district can carry a chlorine residual throughout the entire system. The health department has been satisfied, the district is happy and, most important, the taxpayers were saved a major expense.

Another hazard of the irrigation system lies in the large number of open standpipes which need to be covered.

Several types of low-cost covers are available which will allow venting, at the same time reducing possibility of contamination.

### **Additional Sanitary Problems**

Open canals and low pressure or gravity pipelines require strict regulations and control where they are constructed near sewers or subsurface septic tank drains. In the Vista area, close cooperation with the county health officials guards against construction by private or public agencies of sewage systems near the facilities. Backflow prevention devices must be installed where consumers' pumps boost water pressures to elevations higher than company hydraulic gradient.

In protecting water quality, lakes must also be taken into account. In San Diego County, the few lakes are important recreational areas. Water companies have become dependent on recreational revenues and people need the recreational facilities. The problem is to make use of the lakes for recreation and yet maintain water quality. Strictly enforced rules are posted at all boat docks and licensed fishermen agree to safeguard the water.

A laboratory control on the water in the lakes is maintained by weekly checks of plankton count and bacteriological samples. The water is treated three times with chlorine to insure adequate control of bacteria. The cost of this control and treatment of all the water is made necessary even in Vista where only 20 per cent of the water is being domestically used.

### **Consumer Education**

In the agricultural communities many farmers and orchardists still feel that the use of chlorine in the quantities necessary to oxidize the organic

matter and bacteria in water is actually harmful to their crops. Water often requires 5-7 ppm chlorine to produce a 1-ppm free residual a half a mile below the point of application.

The water consumer has had to be taught that extreme chlorine treatment is required in surface lake waters where contamination exists, and that, as long as filtration is not available, chlorine treatment is the only accepted safeguard.

The consumer may grumble about chlorine tastes and odors but there is a satisfaction in knowing that supply is safe after controlled chlorine treatment.

### **Education of Operators**

Another basic problem with which management was confronted in converting irrigation systems lay in the personnel field. In most systems the operators were trained on the job. They had learned the hard way how many "miners inches" of water they could run without overflowing their reservoirs. They used copper sulfate in the reservoirs two or three times a year when the water looked green, and developed a fine touch in driving a red-wood plug into a leaky main. These practical operators became very proficient and, by working long hours, often developed enviable records of efficiency and service along with very low operational costs.

The change to domestic service and improvements in operating techniques has caused almost every water company to seek more engineering and technical assistance. Problems of bacterial control, pipeline design, pressure tanks, cathodic protection, pump design, and similar every day problems now require a greater percentage of engineers and technically trained personnel.

In San Diego County, as in all California, water works personnel are continually improving their education and training. The work of the California Section has been of great help. Old-time employees, for example, who have completed their Water Works Operators' Courses, have become more proficient in their work. Personnel attitude has a lot to do with the quality of domestic service. Employees must understand that the company policy is changing and that water is now being sold to a new type of consumer demanding more attention and better service.

### **Known Deficiencies**

In San Diego County minimum specifications for water distribution systems have been adopted by the common agreement that these were desirable and necessary. The author believes that all of the major water agencies in San Diego County are meeting or exceeding these specifications on all new work. It must be admitted, however, that in the older portions of irrigation systems, there are places where there is less than 20-psi pressure at the meter. There are still 4-in. water mains more than 1,200 ft in length, and miles of 14-gage steel pipe with only asphaltic coating. Some so-called fire hydrants can discharge but 100 gpm.

No operator is proud of conditions like these. Where the system fulfills its original function and does not serve homes, however, no changes can currently be contemplated. In an area where only one, two or three houses have been built, a new system cannot be afforded. When the whole area is subdivided, however, it has been possible to build a new system with ade-

quate mains for full domestic use and a reserve for fire protection. In the interim period the irrigator still outweighs the domestic user.

### **New Regulations**

New regulations have brought pleasing and varied changes. Service in many systems has been improved by adopting and enforcing fair and equitable new rules for the use of water. Irrigators now understand that domestic use is a higher right than irrigation use. Rates of use and size of services have been adjusted so that the irrigator cannot appropriate water intended for domestic use. Irrigators are strictly scheduled so that each water main is in use throughout the week. In locations having no domestic water pressure, the homeowner is required to install a district-approved booster system with appropriate backflow prevention devices. The domestic user must maintain and operate his own booster plant.

Solving problems like these may appear simple on paper, but to the irrigator and farmer whose economic situation has not been improving with the rest of the economy in recent years, they are real, important, and complex.

Many agricultural communities are still encouraging the development of more agriculture in San Diego County. This is a healthy situation provided that people are kept informed of trends in the cost of water and system improvements necessary with population growth.

To the newcomer any less than the service they had in Los Angeles or San Francisco is not to be tolerated. The newcomers even find it difficult to adjust to the annual assessments that are purely for water company purposes.

They had nothing like that in Los Angeles!

Newcomers expect fire hydrants on every corner. They want water to be served at higher pressures, they do not want to be scheduled for their irrigation, and in most cases, their wants exceed their present ability to pay. The wise water works operator, however, recognizes that growth will continue, and that population 5 or 10 years hence will give them the improved service when they are ready to pay for it.

San Diego County has several agencies charging more than \$100 per acre-foot of water—far too high for practically all agricultural interests. Most San Diego County agencies are now charging more than \$50 per acre-foot. Avocado growers, nurserymen, and most flower growers can bear these costs, but many other agriculturists are forced out. Water prices are set by boards of directors which, in many cases, are still farmer controlled. Water in San Diego County is very valuable and very scarce, and, as many other commodities, is priced to some extent on the supply and demand factor. The demand is high and the supply low, so the price of water is high and apparently going higher.

### **Public Relations**

When and how much to spend on improvements depends on community decisions. The community must naturally be informed of the situation for "silent service is not enough." San Diego County newspapers feature water as a favorite subject. Water boards have the same regular coverage as city councils have in larger cities. In every community faced with water problems, however, more public meetings on

water will have to be held, and consumers will have to be further familiarized with current problems.

### Recommendations

Recent patterns of community growth in Southern California have shown that water works planning and engineering should be concerned with the ultimate development of the community.

Present agricultural developments should not be relied on in planning water facilities of future cities.

Many communities must necessarily be permitted to use substandard irrigation systems until the economy can afford improvements. Irrigators and agricultural water users should be allowed lower water rates for their costs should

not reflect costs of water treatment made necessary by domestic users.

Although many water companies cannot immediately convert their entire systems to meet state health department and county health department standards, they should proceed on many interim improvements which will improve water quality without greatly increasing their costs.

Personnel performance and training programs must be brought up to date to meet the modern problems of the industry.

When all these steps have been taken, irrigators and domestic users will live side by side while both enjoying reasonable service under good operating techniques and adequate rules and regulations.



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## Growing Use of Water for Irrigation in Illinois

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—R. D. Black—

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*A contribution to the Journal by R. D. Black, Instructor, Dept. of Agricultural Eng., University of Illinois, Urbana, Ill. It is being published here for the facts that it presents and because it emphasizes the point concerning the competition of supplemental irrigation that was made in the article "Water for Our Cities," which appeared in the December 1956 issue of Willing Water.*

THE use of water for irrigation in Illinois is increasing sharply, as is evidenced by the rapid rise in the number of acres being irrigated (Fig. 1). Although data gathered by the US Department of Commerce (1) and by state agencies (2) concerning the number of acres irrigated differ markedly, both sets of data show about the same rate of rise in the 1950-57 period, and both curves appear to have a common starting point in 1945. In order to understand how these data can differ so much, one should know something both of the history of irrigation in Illinois and of the methods used in gathering data.

### Methods of Recording Growth

Irrigation in Illinois began in the late 1920's and early 1930's with the irrigation of vegetables, flowers, and nursery stock. The early irrigators discovered that additional water could increase the yield, improve the quality of the products produced, expand operation of business within the same physical boundaries, help secure better stands, supply earlier markets and, in general, remove much of the risk of farming. These early systems, however, were also very expensive and, although the results of irrigation looked very promising, the overhead cost more than offset the advantages except for

high-value crops. Unlike modern lightweight portable irrigation systems, the original systems were fixed in one place. The mains and laterals were either buried or carried overhead and could not be moved with ease. The entire cost of a system thus had to be charged to the small acreage on which the system was installed. In general, these systems were concentrated around the larger population centers. When the *Census of Agriculture* (1) first included irrigation as a minor practice in Illinois, a sampling technique was adopted to gather information for what really was a highly concentrated and specialized activity, so that a small sample in a county was assumed to be representative of the entire county. Since the end of the war lightweight aluminum irrigation pipe has become available in quantity and at a price which has made possible the development of the portable irrigation system. It thus became possible to irrigate greater areas, much to the benefit of low-profit crops. Naturally, the use of irrigation systems expanded greatly in Illinois. The Department of Commerce census, however, although indicating that irrigation was on the increase, failed to take complete account of the fact that the character of the practice had changed. In many counties a single operator might irrigate more acreage than all

the others combined. If he were missed in the sampling, therefore, the county total was quite wrong. When the total acreage in the state is small, the larger operators each represented a high percentage of the total.

The data which were gathered by state investigators (2) were derived from mail surveys and personal contacts

has not been adequate for three reasons:

1. Many systems do not have pump capacities sufficient to maintain desired moisture levels in the root zones of the crops and, consequently, less water than that really needed is used. A farmer, for example, recently reported in a mail survey (3) that he was irrigating 160 acres. His pump capacity, however, could adequately irrigate only 40 acres during extended dry periods. The 160 acres was thus only a potential figure of possible irrigation.

2. In some areas, where surface streams are used as a water supply, the installed irrigation pump capacity of systems along the stream exceeds the flow rate. Roberts (2) points out that Deere Creek near Chicago Heights (a suburb of Chicago) had, during a large part of the growing season, a flow of 4 cfs and an installed pump capacity nearly four times this amount.

3. Many irrigators do not operate their systems properly. They do not maintain proper moisture conditions within the soil profile and, therefore, do not use as much water as might be predicted from estimates based on potential consumptive use. The opposite of this—overirrigation—is not considered to be a significant factor in Illinois. Every irrigator knows that excess water within the soil profile may not only cause damage to the crop, but also will add unnecessary pumping costs to his bill.

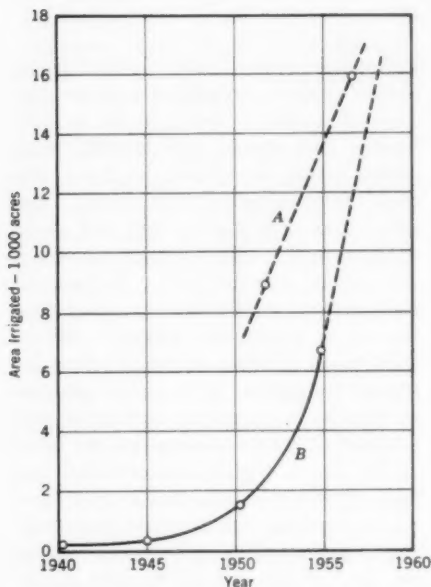


Fig. 1. Illinois Irrigation Trend

Curve A represents data gathered by the Illinois State Water Survey Division. Curve B represents data gathered by the US Department of Commerce

with the irrigators and county farm advisers.

### Inadequacy of Current Methods

In spite of all information gathered, the true extent of irrigation in Illinois is not known exactly. Determination of the existing or potential water use

### Illinois Rainfall

Illinois receives approximately 35 in. of rainfall annually—sufficient to sustain a thriving agriculture throughout most areas but, like all natural occurrences, it is quite variable. The north to south rainfall distribution ranges from 30 in. to 48 in. annually, with

seasonal variations of 65-149 per cent of the average. Sixty per cent of the annual precipitation usually falls during the growing season (from April through September). A study of weather records in Illinois (4) noted that dry periods of 14 days with not more than 0.25 in. of rainfall in 24 hr. can be expected to occur three times during the growing season. Another source (5) states that a 10-day moisture shortage during the critical stage of growth of the corn plant (when the tassel and silk are beginning to shoot) can cause considerable reduction in yield even though the soil moisture level may be adequate during all other stages of growth. Irrigation thus has a definite need to fill.

### Pattern of Development

When, after 1945, irrigation in Illinois began to grow by leaps and bounds, many claims were made both for and against it. Most claims were based, at best, on observations and conjectures—not facts. For a period, unreliable dealers offered substandard services to eager and poorly advised farmers, many of whom soon abandoned irrigation. Irrigation in Illinois was thus considered to be a passing fancy that would eventually die out.

Dealers in irrigation equipment are now quite well established, and the farmers and dealers who pioneered irrigation in Illinois have, with the cooperation of many interested agricultural agencies, helped to establish a pattern of procedure upon which irrigation may safely grow.

How great may be the present or future demand for irrigation water can only be estimated. Present irrigation practice for portable irrigation systems demands that a pumping rate of 10 gpm per acre irrigated be provided in order

to cover the entire area before the soil moisture level in any part of the field can drop below 40 per cent of field capacity. The period may be as short as 3 days for very permeable sands, or, during periods of high consumptive use, as long as 10 days for rather heavy clay loam soils. The period of highest use, unfortunately, usually occurs during July or August when surface streams are low. Original demands for irrigations created no great problems as the systems were fortunately situated in areas of moderate to good water resources and did not require large pumping rates or very great quantities of water. Today, irrigation is spreading all over the state. Increased pumpage rates are required and irrigated areas need large quantities of water. It requires 30,000 gal of water to supply 1 acre-in. If 2 acre-in. will be applied per irrigation, as is usually practiced, a 160-acre irrigated farm may require 9.6 mil gal of water per week during the period of peak use. This represents a pumpage rate of about 960 gpm, 24 hr per day. Irrigators cannot operate 24 hr a day because of the time required to move pipes, between applications. The demand during time of application would therefore, be more nearly 1,200-1,600 gpm.

At the end of the 1951 growing season there were an estimated 9,000 acres irrigated with a total pumping capacity of 25,000 gpm. At the present time, an estimated 16,000 acres are being irrigated and, based partly on 1951 data, there is now an estimated total installed pumpage of 75,000 gpm.

To date the overuse of irrigation water in small areas has only hurt the irrigators themselves. As the use of irrigation spreads, however, all sources of water will be tapped and, eventually, the state legislature will have to recog-

nize the problem and provide adequate laws to govern water distribution. Currently being applied is the ancient law of riparian right which gives owners of lands adjacent to streams or ponds the rights to reasonable use of the water as long as his use does not impair the rights of the other riparian owners. The owner of the land on which water falls may do as he wishes to store or retard its flow onto adjacent lands, and Illinois courts have held that percolating waters are the property of the landowner who may do as he likes with it regardless of his neighbors. This means that the farmer with the biggest pump or the most favorable hydrologic position may render his neighbors' wells useless.

How far the water use for irrigation in Illinois may spread cannot be foretold. It is certain, however, that irrigation has become an established practice, the growth of which may occasionally be retarded by a decline in

prices paid to farmers, but the limits of which will eventually be set by the available water supplies. Dealers have for several years advised their customers to maintain and register with the county clerk a record of the acreage, crops, and amounts of water used during each irrigation season in hopes of establishing prior appropriation rights when the legislature acts.

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## Review of Experiences With Microstrainer Installations

George R. Evans

*A paper presented on Nov. 28, 1956, at the Rocky Mountain Section Meeting, Colorado Springs, Colo., by George R. Evans, Vice-Pres., Glenfield & Kennedy Inc., New Rochelle, N.Y.*

**M**ICROTRAINING is an economical method of removing suspended matter from water and other liquids. In applying the process, microstraining may be used as primary filtration ahead of both rapid and slow sand filtration. The final clarification of sewage effluent is another important municipal use, and similar applications are found in industrial water supply and effluent treatment.

Advantages enjoyed by users of microstraining plants are: low initial outlay, small space requirement, low overall hydraulic head loss of a few inches which renders pumping unnecessary in most instances, and automatic operation at a nominal cost with very low maintenance. In Britain and elsewhere the adoption of microstraining has achieved important economies in the expenditure of public funds where conventional filtration plant would otherwise have been employed.

### Unit Components

The microstrainer is a revolving drum filter operating under open gravity conditions in a rectangular tank usually constructed of concrete (Fig. 1). The essential components and their relationship are:

1. A circular cast-iron endplate with segmental openings built into the concrete or other division wall constructed

between the inlet or raw water chamber and the filtered water chamber in the drum

2. At the opposite end of the unit, connected by four tie bars, a solid cast-iron endplate

3. A hollow drawn steel axle spanning the two endplates and carrying the revolving drum on ball and roller bearings

4. A drum consisting of cast-bronze spiders connected by lifter bars of a similar material, over which the fabric is stretched and fastened down by Monel metal straps

5. The fabric of woven stainless steel wire with apertures as fine as  $23\ \mu$  (or approximately 0.001 in.)

6. A galvanized steel hopper mounted on and opening into the hollow axle

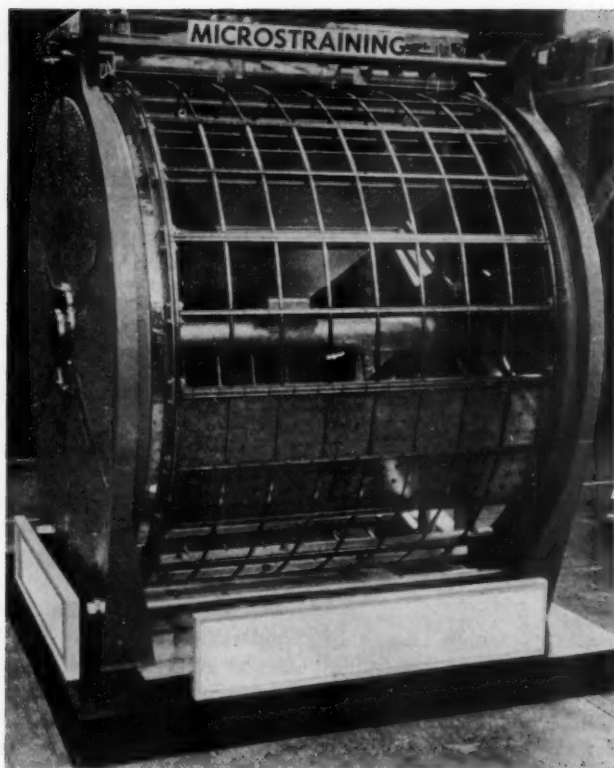
7. A copper header pipe serving spring loaded jets spanning the width of the drum

8. Adjustable felt-lined sealing bands to close the joints between the rotating drum and the stationary end frames

9. A small electric motor and hydraulic, variable speed drive actuating the drum through a bronze spur pinion.

### Processing Water

The raw water enters the inlet chamber under open gravity head; it flows into the revolving drum through the



**Fig. 1. Microstraining Unit on Display**

*The fabric was removed from this large 7½-ft by 5-ft unit.  
The upstream endplate is on the right.*

**TABLE 1**

*Number of Microstrainers in Use or Under Construction and Their Applications—1946–1956*

Period	Ahead of		Sole Filtration of Supplies		Sewage and Industrial Wastes	Miscellaneous	Total
	Slow Sand Filter	Rapid Sand Filter	Public	Industrial			
1946–53	10	1		3	3		17
1954–56	10	8	16	9*	7	4	54
<i>Total</i>	20	9	16	12	10	4	71

\* One in Canada, one in the United States.

upstream frame at the open end and leaves through the fabric. Suspended solids and plankton remain on the inner surface of the fabric. The drum is submerged to about three-fifths of its depth and, at the top of its travel, is cleansed by wash water jets from the header pipe which strike downward through the fabric, thus washing away the solids from the inside of the drum into the waste hopper and away through the hollow axle.

The quality of the raw water and the necessary speed of rotation of the drum dictate the volume of wash water required under operating conditions. Normally a 5-10-psi pressure is adequate, but occasionally 25-30 psi may be needed.

Wash water consumption is kept at a minimum by the adjustable stainless steel self-cleaning nozzles. From records of plants which have been in operation on water supplies for some years, net losses due to backwashing have been found to average 1-1½ per cent of total flow.

Overflow facilities are provided between inlet and effluent chamber in order to avoid excess differential pressures if the drum stops.

The action is thus simple and continuous, and machines have been known to work without stoppage of any kind for 2 or 3 years.

The machines are constructed of high-quality corrosion-resisting materials in conformity with the best water works practice. Consequently, operating and maintenance costs are extremely low: \$1.00-\$1.50 per million gallon including power and a charge for wash water.

The differential head between inside and outside of the drum may rise to as much as 9 in. This permissible variation together with the drum speed,

which can be adjusted to 100 fpm, provides for proper treatment if the quality of the water deteriorates.

The machines are constructed in four standard sizes: The first is 2½ ft in diameter by 2 ft wide; the second, 5 ft in diameter by 3 ft wide; the third, 7½ ft by 5 ft; and the fourth, 10 ft by 10 ft.

Units cover flow capacities up to 10 mgd depending on the quality of the raw water and the extent of removal of the suspended solids required.

Multiple-unit installations are used for large flows and to provide flexibility. Any flow capacity can be obtained from the 7½ ft or 10 ft units operating in parallel. Machines are located in individual tanks with inlet and outlet control valves or sluices, and in the largest plants, construction costs are kept down by installing pairs of machines in single tanks.

The efficiency of filtration by microstraining depends upon the formation of a thin mat of intercepted solids on the inner surface of the filtering fabric. The fabric intercepts solids larger than the apertures so that a mat, collecting material smaller than the apertures, is formed, resulting in high filtration efficiencies. The mat is very thin compared with its equivalent formed on a sand bed (*schmutzdecke*) and is washed off at each rotation of the drum, to be rapidly reformed as the cleaned fabric re-enters the water. The head loss rarely exceeds 6 in., even at the highest flow ratings, and the intercepted solids never, therefore, become so consolidated that they cannot be removed by the low-pressure water jets.

Although microscopic suspended matter of all kinds is filtered out, no appreciable reduction of true colloidal matter or of color in solution can be expected by microstraining.

### Filtering Media

Microstraining fabrics are of woven stainless steel wire, and are very tough and flexible. Three sizes are provided: Mark II, Mark I and Mark O, with apertures of 60, 35, and  $23\mu$  respectively, corresponding roughly to 240, 280, and 380 apertures to the inch. It is because of the high porosity of the microstraining fabrics that high flow ratings, compared with sand filtration, can be used under extremely low differential pressures; and therein lie the economies to be achieved by the process.

involves the concept of the filtrability of fluids.

### Basis of Design

To obtain the total area of a rapid sand filtration plant, it is usually sufficient to divide the total flow by a filtration rate known to be suitable. From this area can be worked out a convenient size and number of beds. Backwashing of such filters is carried out at intervals, varying from a few hours to a few days. Such intervals are not necessarily related to the condition of the water, and a fixed routine of back-



Fig. 2. Colne Valley Water Company Installation

*Three of the six 7½-ft microstrainers which handle a 14-mgd flow.*

The fabric is fitted to the drums and pinned to a coarse mesh stainless steel fabric which provides mechanical support and breaks down surface tension which would otherwise make it impossible for low-pressure backwashing arrangements to be used.

Allowable flow ratings through the fabrics vary up to approximately 30 gpm per square foot, depending upon the concentration of solids in raw water. Arbitrary flow ratings cannot, however, be adopted in designing microstraining installations, as the method employed

washing is often established for operational convenience.

There is no such simple rule for calculating the size of microstraining plant. The mat of intercepted solids retained on the fabric is built up and washed off continuously and rapidly, and a machine treating water heavily charged with suspended solids might have the whole of the fabric matted and backwashed three times every minute. Consequently the size of an installation for a given flow depends upon the maximum rate at which the fabric is matted, which again depends upon the

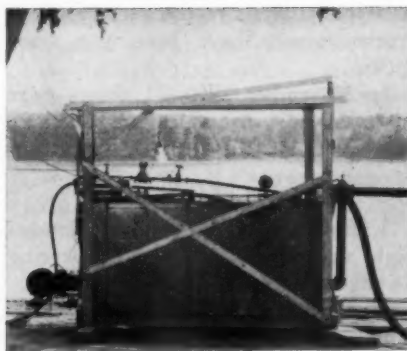


Fig. 3. Pilot Plant at Danvers, Mass.

maximum concentration of solids in the raw water.

The general problem, with representative samples of the water to be filtered is to determine the size and number of machines required and their maximum speed of operation, so that the required flow of water will be passed under a head differential which will avoid a "break-through" of the mat.

An experienced designer might dispense with prolonged sampling, but, where time permits, sampling should cover all seasonal variations of the raw water, especially where very large plants are involved. To obtain the filtrability index, loss-of-head readings are taken on samples of water using the filtrability apparatus (1, 2).

The logarithms of these loss-of-head readings are plotted against volume and

normally show a straight line. A fall-off in the line indicates a break-through of the mat. The index is obtained from the slope of the line with a correction for the apparatus.

Charts are then employed to determine the most economical size and number of machines, based on a formula connecting the following factors: [1] filtrability index; [2] volume of flow; [3] speed of drum and area of fabric; and [4] loss of head across the fabric.

### Applications

New applications of the process are continually arising; the principal uses to date are:

1. To act as a sole filtration process for public and industrial supplies
2. To increase filter runs in both slow and rapid sand filter installations under normal conditions, maintaining their output when the supply is heavily loaded by algae or other matter in suspension, and at the same time, increasing the interval between the cleanings of slow sand beds
3. To provide primary filtration prior to infiltration through natural sand formations with benefits similar to those indicated for slow sand filters
4. To provide postfiltration after flocculation and sedimentation tanks in place of rapid sand filters
5. To anticipate work extensions by increasing output of existing plants

TABLE 2

*Overall Results, Danvers, Mass., Pilot Plant Experiment*

Type of Water	Organisms—per milliliter			Suspended Matter—ppm		
	Max.	Min.	Avg.	Max.	Min.	Avg.
Raw	1,584	72	407	7	3	4
Microstrained	344	0	85	4	2	2.6
Reduction percentage	99	51	79	58	0	36

6. To prevent deposition in the water system; pipes retain their capacity, spray nozzles and showers stay clear

7. To prevent stream pollution by reducing suspended matter content in secondary sewage effluents and industrial wastes

8. To remove materials from process waters rendering both the waste water and the strainer effluent available for reuse

9. To prevent waterborne parasitic diseases. The spread of bilharziasis,

a simple analysis of the uses to which microstrainers have been put since 1946.

In November 1956, 71 plants were in operation or under construction. This number included:

*As Sole Method of Filtration:*

1. Borough of Preston, England—eight machines, 7½ ft by 5 ft, filtering 18 mgd impounded surface water

2. Auckland City Council, New Zealand—one machine, 7½ ft by 5 ft, filtering 1.5 mgd (this auxiliary city supply

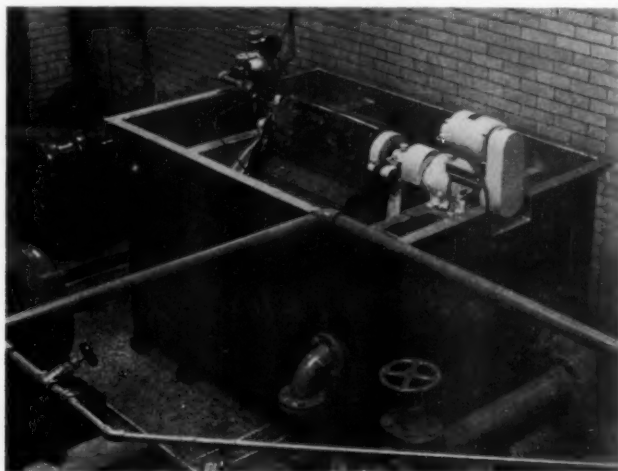


Fig. 4. Belleville, Ont. 2½-ft Pilot Unit

for example, is retarded by screening out the cercarian form of the parasite from irrigation waters.

There is an erroneous impression that the principal use for microstraining is ahead of slow sand filters. While it is true that a greater proportion of the early installations were of that nature, the last few years have seen microstrainers used extensively as a sole filtration process in both public and industrial supplies. Table 1 gives

had suffered an invasion of *Ceratium* which had rendered it unusable until installation of microstrainers \*)

3. Rio de Janeiro, Brazil—two machines, 7½ ft by 5 ft, filtering 5 mgd used for public water supply

4. West Hampshire Water Company, Christchurch, England—three

\* In February 1955, 2,480 *Ceratium* per milliliter reduced by 98 per cent to 42 per milliliter; unpleasant smell removed and improvement in color evident; wash water consumption 1 per cent of total flow.

machines, 7½ ft by 5 ft, filtering 7 mgd industrial supply for refinery

5. Bonner, Mont.—one machine, 7½ ft by 5 ft, filtering industrial supply from Blackfoot River prior to use in log-barking plant

6. Port Alice, B.C.—two machines, 10 ft by 10 ft, filtering 20 mgd to remove *Copepoda*.

#### *Ahead of Slow Sand Filters:*

1. London—four installations filtering 200 mgd

2. Edinburgh, Scotland—two installations filtering 21 mgd

3. Bristol, England—three installations filtering 20 mgd

TABLE 3

*Algal Count, Kempton Park Works*

Unit	Algae	Raw Water Count per mil	Strained Water Count per mil
7½-ft Mark I	<i>Melosira</i> filaments	1,200	175
	<i>Cyclotella</i>	70	15
	<i>Asterionella</i>	15	—
	<i>Fragilaria</i>	15	—
2½-ft Mark O	<i>Melosira</i> filaments	1,100	80
	<i>Cyclotella</i>	60	—
	<i>Asterionella</i>	15	—
	<i>Fragilaria</i>	15	—

4. Liverpool, England—two installations filtering 20 mgd.

#### *Ahead of Rapid Sand Filters*

1. Colne Valley Water Company, Middlesex, England—six machines, 7½ ft by 5 ft, treating 30 mgd to protect chemical and sand filter plant against plankton found in impounding reservoir (Fig. 2)

2. Bridgewater Corporation, Dorset, England—one machine, 7½ ft by 5 ft, filtering 2 mgd impounded river water before pressure filters

#### *Industrial and Sewage Wastes*

1. Colthrop Paper Mills, Berkshire, England—three successive installations, each one 7½ ft by 5 ft machine screening felt washings 3 mgd, thus rendering effluent fit for discharge and waste water fit for reuse

2. Luton, England—3 machines, 7½ ft by 5 ft, straining 4 mgd of secondary effluent (partly activated sludge, partly trickling filters).

#### **Recent Operating Data**

Microstrainers as sole method of filtration were recently tested in Danvers, Mass., by the State Department of Public Health during July, August, and September 1956.

Danvers, a town of 16,000, situated 20 miles northeast of Boston, obtains its water supply from Middleton Pond. The reservoir, 135 acres in extent and 40 ft deep, is served by a catchment area of 1.33 square miles with an emergency supply from the Emerson Brook and has a capacity of 390 mil gal. Because of the swampy nature of the surrounding area, the water carries 60–80 ppm of color. Algal loads up to 2,000 areal units have been experienced, and the suspended solids, normally 2–4 ppm, may, at times, rise to 10 ppm and more. Bacterial pollution is negligible.

A self-contained pilot plant microstrainer, shown in Fig. 3, was installed for continuous operation. The overall results of 40 observations made during the 3-month period is given in Table 2. At this point, it is safe to comment that, in common with most small-scale hydraulic process studies, a larger machine than the one used would have given better results. This is particularly true of wash water consumption which is usually between 1 and 2 per cent in full scale plants, rather than 1–5 per cent incident to this experiment.

Analyses of the waste water at Danvers showed that it contained 600–20,000 organisms per milliliter, and up to 38 ppm of suspended solids—a corroboration of removals indicated by analysis of raw and microstrained water.

Use of microstraining equipment has received the approval of the Massachusetts State Sanitary Engineer. The plans provide for a future consumption of  $4\frac{1}{2}$  mgd to be filtered by three  $7\frac{1}{2}$ -ft units using Mark O fabric ( $23\ \mu$  apertures).

In Canada, a similar experiment to the one at Danvers was carried out at Belleville, Ont. The results obtained were so satisfactory that the installation of four  $7\frac{1}{2}$ -ft units in front of existing sand filters to handle an 8-mgd demand is under consideration. The  $2\frac{1}{2}$ -ft pilot unit is shown in Fig. 4.

The Public Utilities Commission of Brockville, Ont., has approved the purchase and installation of three  $7\frac{1}{2}$ -ft units as sole method of filtration.

The city of Montreal is considering the purchase of one 10-ft machine to use as a pilot installation on their water supply.

Further examples of the effective removal of algae by the microstraining process are provided by tests carried out by the Metropolitan Water Board, London. In 1948, the board installed a battery of four  $7\frac{1}{2}$ -ft units with Mark I fabric with apertures of  $35\ \mu$  at their Kempton Park works. The plant is normally supplied with water from the Queen Mary Reservoir and has 24 primary rapid sand filters with an average filtration rate of 3.48 gpm per square foot, and twelve slow sand filters with an average filtration rate of 0.098 gpm per square foot. The purpose of the tests was to compare the operating efficiency of slow sand filters using strained water with similar filters sup-

plied by water passing through 24 rapid sand filters. As a result of these tests carried out over 4 years (1948–52), the board decided to install microstrainers in their plants at Lee Bridge and Ashford Common.

In 1956, further tests were carried out to determine the effect of microstraining on the raw water fed to one Kempton Park rapid sand filter. A  $2\frac{1}{2}$ -ft pilot unit with Mark O fabric (apertures  $23\ \mu$ ) was placed in front of the filter. Results of the algal count per milliliter obtained on this unit are given in Table 3, together with those obtained on the already installed  $7\frac{1}{2}$ -ft unit ahead of the slow sand filters. A comparison was also made between the operation of the rapid filters served by the pilot microstraining unit and the remaining beds which were receiving unstrained water. The top half of the sand in the filters receiving strained water was removed and replaced with slow filter sand. It was found that during a heavy algal invasion, a run of 72 hr was obtained on the bed receiving strained water, while the filters receiving unstrained water recorded only a 4-hr run. At the same time, the increase in backwashing necessitated the addition of three men to handle the unstrained water filters.

## Conclusions

Among the many clear advantages of using microstrainers are:

1. Low initial costs and small compact layouts: The largest unit, 10 ft by 10 ft, handling 4–12 mgd, requires a chamber about 22 ft by 14 ft overall size
2. Low-powered driving units (cheap running costs): The 10 ft by 10 ft unit is driven by a 4-hp motor
3. Small head losses (open gravity conditions): The head loss through the fabric is rarely more than 6 in. and the

total loss through an installation, including piping and valves, would be 12–18 in.; the high cost of lifting a supply through the 15 to 18 ft necessary for conventional treatment is thus avoided

4. High flow ratings: 5–30 gpm per square foot can be handled

5. Automatic and continuous cleansing (low wash water consumption): Plants in operation for some years at Bristol, England, have recorded consumption of as low as 1.2 per cent

6. Easy operation and intermittent supervision

7. High quality corrosion-resisting materials; minimum replacements.

### Acknowledgments

Grateful acknowledgments are made to the engineers and authorities operating microstraining plants, for permission to include in this paper the information presented.

Similar acknowledgments are made to Glenfield & Kennedy Limited, the manufacturers of the units.

### References

1. BOUCHER, P. L. A New Measure of the Filtrability of Fluids With Application to Water Engineering. *J. Inst. Civ. Engrs. (Br.)* 27:415 (1947).
2. MATHESON, DELOSS H. Improved Water Filtrability Test. *Wtr. & Sew. Wks.*, 101:517 (Dec. 1954).

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## Discussion

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### E. Windle Taylor

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The London Metropolitan Water Board operates several microstraining installations. A plant at Lee Bridge, installed in July 1955, is capable of dealing with 72 mgd. The filtering efficiency of this plant is shown graphically in Fig. 5, and a summary of some of the results obtained for the first 12-month period is given in Table 4. It will be noted that microstrainers perform most efficiently when the water has a large algal content.

The only difficulties in operations have been in getting rid of wash water and in having local growths block the mesh. The first is overcome by supplying adequate drainage arrangements, and the second by taking individual strainers out in turn and treating the mesh with hypochlorite solution.

Use of microstrainers has brought no improvements either in bacterial or chemical quality of the water, but this is of little importance as reliance is

placed on slow sand filters and terminal chlorination.

In a report (1) to the Metropolitan Water Board, it was recently said:

The board's primary filters, operated at rates somewhat over 2 gpm per square foot, serve to remove the greater part of the suspended matter from the stored water and so relieve the load on the secondary filters which are worked at about 0.08 gpm per square foot as compared with less than 0.04 before the installation of these filters. No significant bacteriological improvement is looked for in the primary stage nor is there any great reduction in color. The desired improvement in these characteristics is achieved in the secondary filters, where also the fine particles of suspended matter, almost colloidal in character, and which do not settle out in the storage reservoir, are largely removed. The primary filters are, however, very efficient in removing the small concentrations of ammonia present in river waters such as those of the Thames and Lee. The sand of the filters becomes colonized by nitrogen-oxidizing bacteria which can cope with up to 3 or 4 ppm of ammonia in the short time that the water takes to pass through the bed. These or-

TABLE 4

*Monthly Averages and Other Observations of Microstrainers Performance, Lee Bridge, England*

Before Strainers				After Strainers		
Date	Avg Filtrability Percentage	Organisms*	Avg Silt	Avg Filtrability Percentage	Organisms*	Avg Silt
1955						
Jul.	46	moderate mixture: A, B, C, D, E; fair amount: P	moderate	60	light mixture: B, D, E	little
Aug.	53	moderate mixture: C, D, B, G, A, E; few: E, H; little: P	moderate	72	light mixture: D, A, E, F	little
Sep.	56	moderate mixture: H, G, E, F; few: I, K	little	77	light mixture: E, F; few: I	little
Oct.	70	fairly light mixture: H, G, B, D, E, F	little	86	few: E, F; occasional: B	very little
Nov.	79	light mixture: E, F; occasional: I	very little	85	few: F; occasional: I	very little
Dec.	72	occasional: L; little: P	very little	81	practically no algae	very little
1956						
Jan.	75	practically no algae; little: P	little	79	practically no algae	very little
Feb.	74	few: L, I, F	very little	78	occasional: F, L	very little
Mar.	37	heavy mixture: L, I, F; few: E, M; little: P	moderate	59	fairly light mixture: L, I, E, F; few: M	little
Apr.	59	moderate mixture: L, H, B, I, E, F	little	71	light mixture: L, B; occasional: F	little
May	70	light mixture: H, B, E, F; few: I; few: N	little	79	occasional: B, F	very little
Jun.	69	moderate mixture: E, F; few: H, B; little: P	little	77	very light mixture: B, F	very little

\* The following is a key to the letters used in the table:

A—*Tribonema*; B—*Stephanodiscus hantzschii*; C—*Aphanizomenon*; D—*Cyclotella*; E—colonial Chlorophyceae; F—unicellular Chlorophyceae; G—*Melosira*; H—*Fragilaria*; I—*Synedra*; K—*Pediastrum*; L—*Asterionella*; M—*Stephanodiscus astraea*; N—rotifers; P—organic debris.

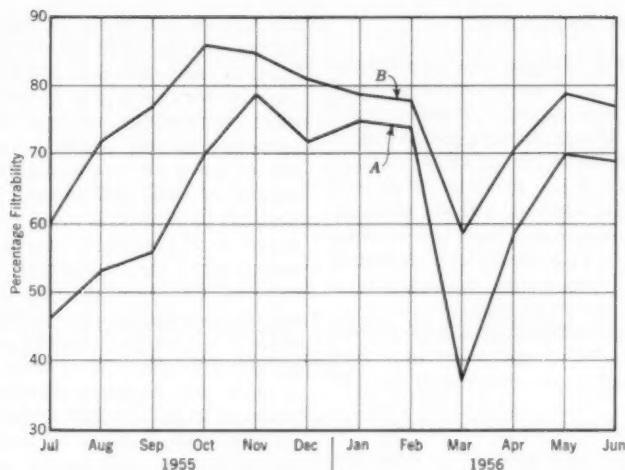


Fig. 5. Filtrability Percentage Before and After Microstraining

Curve A representing filtrability before the use of microstrainers at Lee Bridge, England, is contrasted with Curve B which represents filtrability after strainers were installed.

ganisms are inactive at temperatures below about 4°C.

During and after the 1939-45 war, the board had to arrange a program of reconstruction; material for building and engineering was scarce and expensive and it was abundantly necessary to practice economy wherever possible. Experiments that had been performed with a small prototype manufactured many years ago had encouraged a belief that the main work of the primary filters could possibly be done by some similar form of mechanical strainer and an approach was accordingly made to a firm who manufactured such equipment. The problem was ex-

plained to them; an indication being given of the order of size of particle which the strainer should retain.

The resulting equipment took the form of a rotating cylindrical strainer 5 ft long and 7½ ft in diameter on a horizontal axis, and the cylindrical surface covered with a very finely woven fabric of Monel metal. The strainer was suspended in a specially constructed tank, the level of water in it being arranged that most of the cylinder was submerged. One end of the cylinder was open and served to introduce the subject water to the inside of the strainer. This open end fitted snugly against a plate and, the other end of the cylinder being closed, water had perforce to pass outwards through the meshes of the strainer. Suspended matter in the water adhered to the inside surface of the wire fabric and was removed by external jets of water impinging down on the top of the rotating strainer, the washings being caught in a stationary trough above water level inside the equipment and rejected from a pipe passing through the axis. The strainer was rotated by a variable speed electric motor, the speed of rotation being of the order of 1 to 2 rpm.

TABLE 5

Summary of 4-year Microstrainer Operations, Surbiton Works, Surrey, England

Bed Number	No. of Times Cleaned	Amount Filtered per Acre Cleaned mil gal	Avg Rate of Filtration gpm per sq ft
6*	42	100.66	0.071
7†	55	53.11	0.040
8†	56	52.53	0.044

\* Strained water.

† Unstrained water.

### *The Surbiton Experiment*

It was not at first possible to install the microstrainer at a works where a direct comparison with primary filtration could be staged. It was accordingly placed at the Surbiton Works in order to compare the performance on the one hand of a slow sand filter together with the strainer, and on the other, a slow sand bed working on its own. This work was continued over several years and showed that a slow sand filter could generally be operated at a rate conforming with that used in dual filtration if the water were first passed through a microstrainer of the type in question.

At first a wire mesh of 160 by 160 meshes to the inch was used. This was later replaced by one having in one direction 56.5 wires to the inch of 0.0022-in. diameter wire, and in the other, 75 pairs of wires of 0.0024-in. diameter. As the maximum output of the strainer under the worst conditions of algae would be about 1.8 mgd, and as this output would be insufficient to permit the chosen filter bed to be operated at the desired rate, the filtering area of the bed was reduced from nearly an acre to 0.3 acre by laying paving slabs over part of the sand. There were two control beds. Of these, it would have been desirable to work one at the same rate as the one used for the experiment, but for various reasons, this was not practicable. Accordingly, the two control beds were operated similarly to each other at a rate of approximately 0.04 gpm per square foot. The filters were cleaned when the loss of head was 2 ft 6 in. more than that which had obtained at the beginning of the run. The strainer was rotated at such a rate that the loss of head through it was not more than 3 in.

An important incident occurred in June 1949, when the microstrainer was receiving water from Island Barn reservoir. Comparisons were being made between the duration of the filter run of slow sand filter beds receiving the effluent from this plant and others receiving unstrained water. The reservoir phytoplankton at this time consisted almost entirely of *Fragilaria* and *Tribonema*, both of which

had a high proportion of long filaments but the growth could only be regarded as light to moderate and not abnormal in quantity for this highly productive reservoir. Because of increased head losses occurring on the microstrainer, the inside of the drum was inspected and large masses of these filamentous algae were found to be trapped between the straining gauze and the inner supporting wire meshwork. The micromesh gauze had removed a large proportion of the algae but the backflushing jets had been unable to force the material through the supporting wires so that the accumulated masses of algae were impacted between these two layers of gauze. A fair proportion of the material was detached by hosing the inside of the drum, but further removal was not effected until strong hypochlorite solution was poured over the outside of the strainer whilst it was slowly revolved by hand. It was also necessary to leave the strainer rotating slowly in a strongly chlorinated water for several hours followed by normal backflushing before complete removal of the algae was obtained.

Most of the board's reservoirs often have very dense growths of filamentous Xanthophyceae diatoms and Myxophyceae and this kind of trouble would be of immense importance to a works relying solely on microstrainers for primary treatment as it might possibly lead to some interruption in the supply of treated water. The manufacturers have since modified the strainer by removing the inner supporting wire mesh and attaching the micromesh gauze to the outer mesh; so far, no further trouble has been experienced when dealing with waters containing filamentous algae.

The results of 4 years work showed that the strainer assisted filtration in no small degree. Table 5, which is a summary of operations over this period, demonstrates this quite clearly.

### Reference

1. MACKENZIE, E. F. W. Thirty-Fifth Report on the Results of the Bacteriological, Chemical, and Biological Examination of the London Waters for the Years 1947-1952. Metropolitan Water Board, London (1954).

**A Survey of Operating Data for Water Works  
in 1955**

***Staff Report***

**AMERICAN WATER WORKS ASSOCIATION**

***Incorporated***

**2 Park Avenue, New York 16, N.Y.**

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# A Survey of Operating Data for Water Works in 1955

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## Staff Report

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THE results of the Association's survey of operating data for water works in 1955 are tabulated on the following pages. (An analysis of these data will be published in a forthcoming issue.) The questionnaire form illustrated on pages 556-58 was sent to approximately 1,100 water utilities serving populations of 10,000 or more. A total of 497 utilities returned executed forms in time for inclusion in this tabulation. This is the third such survey conducted by the Association, and the response, both in number of returns and in their scope and completeness, considerably exceeded that attained by the 1945 and 1950 surveys (1, 2).

An attempt was made to word the questions in the survey in such a way that they would apply to the large majority of water utilities. Because of individual differences in methods of record keeping, billing, and accounting, however, the replies were not always in a form best suited for comparison. Accordingly, requests for further information were sent to a large number of utilities. Also, an effort was made in some cases to convert the data furnished into a more usable form. It is hoped that the errors resulting are minor.

The items covered in the tabulation are listed and explained below.

### Table 1—Physical Data

*Column 1—Community.* Communities are listed in alphabetical order for easy reference. The number preceding the name is repeated in the first column on the right-hand page. A given city

will retain the same number in each of the four tables. Data tabulated are for the calendar year 1955, except as noted by superscript numerals following the name of the community; for example, <sup>7/55</sup> indicates that the data are for the year beginning July [first] 1955. Full names and other relevant information for some of the utilities and communities served are presented in notes on pages 694-96.

*Columns 2 and 3—Population Served.* These columns show the best available estimate of retail and wholesale population served, both to the nearest thousand. Where the two were not segregated, the total is tabulated in Col. 2, with an appropriate note in Col. 3.

*Column 4—Public Control Agency.* For publicly operated utilities, a numerical code indicates whether the water utility executive is responsible to the mayor; council; board of public works; water board or commission; water authority or district; city manager; city commission or commissioner; director of public works; or some combination of these. Privately owned utilities are identified by "pvt."

*Columns 5-7—Source of Supply.* These figures indicate the percentage of the utility's water supply derived from surface and ground sources, or purchased wholesale. Where percentage figures were lacking, checkmarks (✓) indicate the source of supply.

*Column 8—Type of Treatment.* A numerical code is again used to indicate filtration; softening; chlorination; corrosion control; iron or manganese re-

# 1. Community or Communities Served

NAME OF EACH INCORPORATED COMMUNITY

POPULATION SERVED IN 1955

RETAIL (R) or  
WHOLESALE (W)

Unincorporated Suburban .....

Total Population Served .....

# 2. Ownership

☐ Private—by .....

(NAME AND ADDRESS OF HOLDING COMPANY, IF ANY)

☐ Public—Water Utility Executive Responsible to:

☐ Mayor ☐ Council ☐ Board of Public Works ☐ Water Board or Commission

☐ Water Authority or District ☐ Other .....

# PHYSICAL DATA

3. Type of Supply: ☐ Surface water ☐ Ground water ☐ Both: .....% Surface and .....% Ground  
☐ Neither — supply purchased from: .....

4. Treatment (if only one type of supply used, merely check; if both types used please indicate by S, G, or B, whether treatment applies to surface water, ground water, or both; if purchased, do not answer)

..... Filtration ..... Softening ..... Chlorination ..... Corrosion control

..... Iron and/or manganese removal ..... Taste and odor control ..... Fluoridation

..... Other, as follows: .....

5. Supply to Distribution System: ☐ By gravity ☐ Pumped

# 6. Power for Pumping

Raw Water to Treatment Plant: ☐ Steam ☐ Electric ☐ Diesel ☐ Other .....

Finished Water to Distribution System: ☐ Steam ☐ Electric ☐ Diesel ☐ Other .....

Booster Pumping for High Service: ☐ Steam ☐ Electric ☐ Diesel ☐ Other .....

# 7. Storage of Finished Water on Distribution System

☐ Elevated Tanks: Number ..... Total capacity ..... gal.

☐ Ground Storage Repumped: ..... Total capacity ..... gal.

☐ Reservoirs (gravity): ..... Total capacity ..... gal.

# 8. Pressure on Distribution System

Business District: Maximum ..... lb/sq in. Minimum ..... lb/sq in.

Residential Area: Maximum ..... lb/sq in. Minimum ..... lb/sq in.

9. Average Temperature of Distributed Water: January ..... °F July ..... °F

# BASIC DATA ON PRODUCTION AND SALES

# 10. Transmission Mains

Distance from source to treatment works, distribution reservoir, or pumping station ..... miles

Size or sizes of mains ..... in. Total length (if more than one) ..... miles

Fig. 1a. Water Works Data Questionnaire, 1955

**11. Length and Size of Distribution Mains** (mains within service area which provide water to customers):

..... miles of 4-in. main ..... miles of 12-in. main ..... miles of 20-in. main  
 ..... miles of 6-in. main ..... miles of 14-in. main ..... miles of 24-in. main  
 ..... miles of 8-in. main ..... miles of 16-in. main ..... miles of 30-in. main  
 ..... miles of 10-in. main ..... miles of 18-in. main ..... miles of 36-60-in. main

**12. Total Number of Distribution System Valves** (NOT including hydrant branches) .....

**13. Total Number of Distribution System Hydrants** (Public fire hydrants on city streets) .....

**14. Total Water Produced in Year Reported:** ..... gal

**15. Total Water Distributed in Year Reported:** Sold: ..... gal; "Free Service": ..... gal

**16. Customer Record**

CLASS OF SERVICE	NUMBER OF ACTIVE SERVICES		BILLING PERIOD FOR METERED SERVICE (Use abbreviations noted below to indicate period)
	METERED	NOT METERED	
Domestic			
Commercial			
Industrial			
Public (municipal uses, etc.)			
Total			Annual (A); Semiannual (SA); Quarterly (Q); Sixmonthly (S); Monthly (M)

**17. Billing and Collection Practice**

Minimum domestic or residential charge per month: \$ .....

☐ Plus "slow-pay" penalty of .....

☐ Less prompt-pay discount of .....

☐ Net

Quantity of water allowed on minimum bill ..... gal

**18. Type of Rate Schedule**

☐ Service (meter) charge plus water charged at: ☐ Uniform rate ☐ Nonuniform rate

☐ Minimum charge, with: ☐ Water at uniform rate ☐ Water at nonuniform rate

**19. Metered Water Rates per Month** (Indicate actual charge for stated amount if paid promptly; if billing is quarterly, calculate charge for 3,000, 30,000, etc., cu ft and divide result by 3; if schedule is in gallons, use ratio 7,500 gal = 1,000 cu ft; include service (meter) charges, if any, assuming  $\frac{3}{8}$ - or  $\frac{1}{2}$ -in. meter for 1,000 cu ft per month, 1-in. for 10,000, 3-in. for 100,000, and 8-in. for 1,000,000):

For 1,000 cu ft—\$ ..... For 100,000 cu ft—\$ .....

For 10,000 cu ft—\$ ..... For 1,000,000 cu ft—\$ .....

**20. Percentage of Year's Billing Written off as Uncollectable:** .....%

**FINANCIAL DATA**

**21. Income**

Residential service ..... \$ .....

Commercial service ..... \$ .....

Industrial service ..... \$ .....

Private fire protection service ..... \$ .....

SUBTOTAL \$ .....

Fig. 1b. Water Works Data Questionnaire, 1955

Public service (municipal uses, etc)—if collected ..\$ .....		
Public fire protection—if collected ..\$ .....		
<input type="checkbox"/> (Charge per hydrant—if collected \$ .....		
<input type="checkbox"/> (Charge per inch-mile—if collected \$ .....		
Miscellaneous service ..\$ .....		
	SUBTOTAL	\$ .....
	TOTAL INCOME	\$ .....
<b>22. Free Service Value</b>		
Public buildings ..\$ .....		
Fire hydrants ..\$ .....		
Other service ..\$ .....		
	TOTAL FREE SERVICE VALUE	\$ .....
<b>23. Expenses (Omit expenses of capital additions or depreciation)</b>		
Operating expenses—including services and wages ..\$ .....		
Maintenance expenses—including services and wages ..\$ .....		
(Number of regular employees—average ..)		
Taxes—Local ..\$ .....		
Taxes—State ..\$ .....		
Taxes—Federal ..\$ .....		
Miscellaneous ..\$ .....		
	TOTAL EXPENSES	\$ .....
<b>24. Capital Additions During Period</b>		
Funded from prior earnings ..\$ .....		
Funded by bonds:		
General obligation ..\$ .....		
Revenue bonds ..\$ .....	\$ .....	
Funded by bank loans ..\$ .....		
	TOTAL CAPITAL ADDITIONS	\$ .....
<b>25. Disposition of Earnings for Year</b>		
Interest on bonds and funded indebtedness ..\$ .....		
Set aside for funded debt retirement ..\$ .....		
Direct expenditure for capital additions ..\$ .....		
Bonds retired by payment ..\$ .....		
Dividends to stockholders (private ownership) ..\$ .....		
Payments to city funds or regional water districts (public ownership) ..\$ .....		
Depreciation—if funds are not actually set aside, circle amount to show this is "accounting record" ..\$ .....		
Added to utility's reserve funds ..\$ .....		
Other (Specify) ..\$ .....		
	TOTAL [Should equal TOTAL INCOME (21) minus TOTAL EXPENSES (23)]	\$ .....
<b>26. Book Value of System at End of Period of Report—less accrued depreciation</b>		
Supply works and transmission lines ..\$ .....		
Treatment and pumping works ..\$ .....		
Distribution system ..\$ .....		
General property—service and office buildings and equipment ..\$ .....		
	TOTAL BOOK VALUE	\$ .....
	TOTAL DEPRECIATION RESERVE FUNDS	\$ .....
	TOTAL SURPLUS INCOME HELD IN RESERVE	\$ .....
	TOTAL FUNDED DEBT	\$ .....

Fig. 1c. Water Works Data Questionnaire, 1955

removal; taste and odor control; fluoridation; or various combinations of these. Where column 8 is blank, no information was furnished; this was generally the case with purchased supplies, for which treatment information was not requested.

*Columns 9-11—Pumping Power.* Here the numerical code indicates whether steam, electric, diesel or other types of power are used for pumping—from source to treatment plant, Col. 9; to distribution system, Col. 10; booster on distribution system, Col. 11—or whether a gravity system, requiring no pumping, is in use. Some misunderstanding of the questionnaire is indicated by the fact that a great number of utilities reported both electric pumping and gravity supply to the distribution system. Standby power was not considered in the tabulation.

*Columns 12-16—Distribution Storage.* The intention here was to assemble data on the storage of finished water on the distribution system, in elevated tanks (Col. 12), ground storage reservoirs from which pumping is required (Col. 13), or "gravity" reservoirs (Col. 14) which are also on the ground but located above the distribution system and thus functioning as elevated storage. Total distribution storage is tabulated in Col. 15, and Col. 16 shows a calculated value for the number of days' average water use which this storage volume represents (based on the annual production data reported in Table 2, Col. 11). Data in Col. 12-16 were tabulated to one decimal place only; values less than 0.05 are recorded as 0.0. Some difficulty was occasioned by the reporting of impounded storage not actually available on the distribution system.

*Columns 17-20—Distribution Pressures.* Tabulated here are maximum and minimum distribution system pres-

sures reported for business and residential districts.

*Columns 21 and 22—Distribution Temperatures.* Average January and July temperatures in the distribution system are given in degrees Fahrenheit.

### **Table 2—Production and Distribution Data**

*Column 1—Community.* See explanatory comment on Table 1, Col. 1.

*Column 2—Transmission Mains.* This column shows the total length of pipelines devoted to carrying water from the supply source to the treatment plant or distribution system.

*Columns 3-6—Distribution Mains.* Tabulated here to the nearest mile are the length of distribution mains 4 in. to 8 in., inclusive (Col. 3), the length of 10-in. and larger mains (Col. 4), and the total mileage in these two categories. (Col. 5). From this total and the retail population data of Table 1, Col. 2, the miles of main per 1,000 retail population were calculated (Col. 6).

*Columns 7-10—Valves and Hydrants.* The total number of distribution system valves, not including those on hydrant branches, is shown in Col. 7. The total number of public fire hydrants on city streets is tabulated in Col. 9. Columns 8 and 10 show the calculated number of valves and hydrants, respectively, per mile of distribution main reported in Table 2, Col. 5.

*Column 11—Production.* This column records total annual water production or purchase.

*Columns 12-14—Distribution.* In a departure from the two previous surveys, a request was made for data on both total annual water sales (Col. 12) and free water service (Col. 13). Approximately 90 utilities reported the entire difference between production and sales as free service, thus implying

that 100 per cent of production was accounted for. When free service was not reported, Col. 13 was left blank, and the amount sold was accepted as total distribution. When free service was reported as "none," or as a numerical value, this was recorded in Col. 13, and the sum of Col. 12 and 13 was entered as total distribution in Col. 14. When it was stated that the amount of free service was not known, this was noted in Col. 13, and Col. 14 was left blank.

**Column 15—Per Cent Production Unaccounted for.** Where both production and total distribution figures were available, their difference (Col. 11 minus Col. 14) divided by the production figure (and multiplied by 100) yielded a calculated value for the percentage of production unaccounted for. As pointed out above, a number of returns showed all water accounted for, a utopian situation to which all might aspire. It should also be noted that, where use is not fully metered, the percentage unaccounted for is not necessarily all "lost" water.

**Columns 16 and 17—Production and Distribution (gallons per capita per day).** These calculated values were obtained by dividing production (Col. 11) and total distribution (Col. 14) figures, respectively, by 365 times the total population served (Table 1, Col. 2 plus Col. 3).

**Column 18—Loss per Main-Mile.** The difference between production and total distribution (Col. 11 minus Col. 14) was divided by 365 times the distribution main mileage (Table 2, Col. 5) to give the calculated line loss per mile in 1,000-gpd units. See comments on Col. 13 and 15.

### **Table 3—Services, Billing, and Rates**

**Column 1—Community.** See explanatory comment on Table 1, Col. 1.

**Column 2—Number of Employees.** This column gives the average number of regular employees.

**Columns 3–7—Customers.** Tabulated here are the number of customer or service accounts classed as residential (Col. 3), commercial (Col. 4), industrial (Col. 5) and public (Col. 6). Where the data reported did not fit this breakdown, appropriate notes appear in the tabulation. The total number of customers is given in Col. 7.

**Columns 8 and 9—Services Metered.** The figures in Column 8 indicate the percentage of residential services metered. For cities providing no breakdown by type of service, this figure may indicate the percentage of all services metered, as pointed out by a footnote. Unless otherwise noted, commercial and industrial services were reported to be fully metered. Column 9 shows the percentage of public service connections metered.

**Column 10—Residential Billing Period.** This column indicates whether residential customers are billed on a monthly, bimonthly, quarterly, semi-annual, or annual basis (or some combination of these). No attempt was made to tabulate the wide variety of billing periods for commercial or industrial accounts.

**Column 11—Minimum Charge per Month.** The minimum residential charge is shown. When the minimum charge is, or includes, a service charge, a  $\frac{5}{8}$ - or  $\frac{3}{4}$ -in. meter is assumed. Although minimum charges were reported for various billing periods (sometimes unspecified), careful effort was made to convert these correctly to a monthly basis for comparison.

**Column 12—Penalty or Discount.** Penalty or discount provisions, or lack of them, in the billing terms are tabulated in this column. For example, "P-15" indicates a penalty of 15 per

cent of the bill for late payment, while "D-\$0.50" indicates a discount of 50 cents from the amount billed for prompt payment. "N" indicates that the amount shown is due without such provisions.

**Column 13—Allowance on Minimum.** This column shows the monthly quantity of water allowed for the minimum charge in Col. 11. If the quantity allowed is shown as 0 in the table, the charge in Col. 11 is a service charge. Where all or most domestic users are on a flat rate, a footnote indicates that the quantity allowed is unlimited. Blank spaces in this column indicate that no information was furnished.

**Columns 14-17—Monthly Rates.** These columns present a tabulation of monthly metered rates for the four quantities shown. Where rates for a billing period other than monthly were submitted, they were converted to a monthly basis if a rate schedule was furnished. For quarterly billing, for example, charges were calculated for 3,000, 30,000, etc., cu ft per quarter, then divided by 3. Rates in terms of gallons were converted to cubic feet on the basis of the commonly used equation, 7,500 gal = 1,000 cu ft.

When service or meter charges were reported, the following meter sizes were assumed:

Monthly Quantity cu ft	Meter Size in.
1,000	½, ¾
10,000	1
100,000	3
1,000,000	8

The service charge was then added to the quantity rate to arrive at the total amount billed. Where it was reported that no customers were served in the highest bracket, the space was left blank. In all cases, the rates tabulated were intended to be the charges for prompt payment, taking advantage of

discounts offered and avoiding penalties for late payment.

**Columns 18 and 19—Public Fire Service Charge.** Annual charges by the water utility to the local governmental unit for public fire protection are shown, per hydrant (Col. 18) and per inch-mile of main (Col. 19). Special situations are described by appropriate footnotes. Where it was reported that no such charge was made, "none" appears in the tabulation. Blank spaces indicate that no information was furnished.

**Column 20—Billing Written Off.** The percentage of the year's billing written off as uncollectible is given. When it was stated simply that the amount was less than 1 per cent, the symbol "< 1" so indicates. If the amount reported was less than 0.005 per cent, the figure 0.00 was tabulated. If the return stated that no such loss was written off, "none" was entered in this column. Some of the data represent actual experience, while others may be considered a reserve against this type of loss.

#### Table 4—Financial Analysis

Because of the many items included in this table, it was necessary to extend it across four pages, instead of two as in Tables 1-3. The first two pages are labeled "Part I"; the last two, which follow immediately, are labeled "Part II." The columns are numbered continuously throughout the four pages.

**Column 1—Community.** See explanatory comment on Table 1, Col. 1.

**Columns 2-11—Revenue.** These figures indicate the amount of income received from residential (Col. 2), commercial (Col. 3), and industrial (Col. 4) accounts, and from private fire protection service (Col. 5); income from these four sources is totaled in Col. 6. Also tabulated is the revenue received

from public or municipal services, if actually collected (Col. 7); from public fire protection (such as a hydrant charge), if actually collected (Col. 8); and from all miscellaneous services or activities (Col. 9). Where a complete breakdown of income was not furnished, the tabulation provides as much information as was available. Total revenue from all sources is shown in Col. 10, and this figure was divided by the retail population served (Table 1, Col. 2) to yield calculated figures for total revenue per capita (Col. 11). As appreciable income is derived by a number of utilities from wholesale accounts and from sources other than water sales, the per capita figures are subject to a good deal of interpretation.

*Column 12—Free Service Value.* The amounts estimated for the dollar value of services not billed, such as public buildings and public fire protection, are shown here. If reported as none, this was indicated in the column; where no information was furnished, the space was left blank.

*Columns 13–18—Expenses.* Utility operating expenses were tabulated in Col. 13, and maintenance expenses in Col. 14. Where the two were not separated, the combined cost was shown as operating expense, with an appropriate note in Col. 14. Column 15, listing taxes, presented genuine problems in that many publicly owned utilities transfer money to city funds in lieu of taxes. Some of these transactions are lump-sum payments acknowledged to be simply transfers, while others are determined according to regulatory practices and are considered to be local taxes. Wherever it seemed warranted, such local payments by publicly owned utilities were omitted from Col. 15 and tabulated in Col. 37 as a disposition of earnings. Where social security or

similar retirement costs were reported as taxes, they were included instead with operating costs. Miscellaneous expenses (Col. 16) were usually considered to be nonoperating; general and administrative costs were considered to be operating expenses. (The survey questionnaire form indicated that capital additions and depreciation were not to be considered as expenses but were to be shown under disposition of earnings.) The figure in Col. 17 shows the total of expenses in the four preceding columns, and this figure was divided by the retail population (Table 1, Col. 2) to arrive at the calculated total expense per capita (Col. 18).

*Column 19—Tax Paid.* The amount of tax paid (Col. 15), expressed as a percentage of total revenue (Col. 10), is given here. Calculated values less than 0.05 are shown as 0.0 in the tabulation.

*Columns 20–24—Source of Funds for Capital Additions.* These columns indicate the various sources of financing for major capital additions, such as prior earnings and reserves (Col. 20), general-obligation bonds (Col. 21), revenue bonds (Col. 22), and bank or similar loans (Col. 23). Column 24 shows the total funds from these sources. For utilities indicating no financing, "none" is shown in Col. 24; blank spaces in this column indicate that no information was furnished.

*Columns 25 and 26—Depreciated Book Value.* These figures show total depreciated book value to the nearest thousand dollars (Col. 25) and corresponding per capita values to the nearest dollar (Col. 26), calculated from the retail population data in Table 1, Col. 2. Book values which are undepreciated are identified by a footnote.

*Columns 27–29—Depreciation Reserve Funds, Surplus in Reserve, and*

**Funded Debt.** These columns indicate, to the nearest thousand dollars, the size of reserve funds (Col. 27 and 28) and the amount of funded debt (Col. 29). When depreciation reserves were reported to be an accounting record only, this was noted. Where either of these funds, or the funded debt, was reported to be nothing, "none" appears in the tabulation. Blank spaces indicate a lack of information in the survey return.

**Column 30—Operating Ratio.** Tabulated here are calculated values of the operating ratio, the proportion of total expense (Col. 17) to total revenue (Col. 10), expressed in the form  $1:x$ , where  $\text{expense} = 1$  and  $\text{revenue} = x$  = Col. 10  $\div$  Col. 17.

**Column 31—Earnings.** The difference between total revenue (Col. 10) and total expense (Col. 17) is shown as "earnings" in this column.

**Columns 32-39—Disposition of Earnings.** The wide variety in accounting and reporting methods made the interpretation of data for these columns difficult. Interest paid on bonds and funded debt is shown in Col. 32; amounts set aside for debt retirement (into sinking funds, for example) appear in Col. 33; the amount of bonds retired appears in Col. 35. The chance of duplication in these three columns is apparent, as well as the possibility that some of the money expended came from surplus or sinking funds rather than current earnings. Similarly, direct expenditures for capital additions from current earnings (tabulated in Col. 34) were sometimes lumped with capital expenditures from prior earnings (Col. 20). Dividends to stockholders of privately owned utilities are shown in Col. 36. Amounts transferred to city general funds are shown in Col. 37; also included in this column, with appropriate

annotations, are "local taxes" paid by publicly owned utilities, payments to regional water districts, sewer system allocations, and outlays for purposes not otherwise itemized. Column 38 indicates depreciation charged, with footnotes to distinguish between amounts actually set aside and those representing accounting records only. Column 39 shows the amount added to surplus or reserve after other commitments have been met. Negative figures here indicate that sometimes it was necessary to dip into the surplus remaining from previous years.

The financial section of the questionnaire was set up so that, if the data were reported as requested, the total disposition of earnings (Col. 32-39) would equal the difference between total revenue (Col. 10) and total expenses (Col. 17), this being the figure shown as "earnings" in Col. 31. In spite of the problems and pitfalls mentioned above, these figures balance for approximately three-fourths of the utilities reporting.

### Acknowledgment

The tabulation of the survey data was carried out under the direction of Harris F. Seidel, superintendent of water and sewage treatment, Ames, Iowa, with the collaboration of E. Robert Baumann, associate professor of civil engineering, and Paul E. Morgan, assistant professor of civil engineering, Iowa State College, Ames, Iowa.

### References

1. A Survey of Operating Data for Water Works in 1945. *Jour. AWWA*, **40**:167 (Feb. 1948).
2. A Survey of Operating Data for Water Works in 1950. *Jour. AWWA*, **45**:583 (Jun. 1953).

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
1. Aberdeen, S.D.	23,000		7	100			1-3, 6, 7
2. Adrian, Mich. 7/55	20,000		4	100			1-4, 6
3. Akron, Ohio	297,000	1,000	8	100			1, 3-6
4. Albany, N.Y.	135,000		1	√	√		1, 3, 5, 6
5. Albemarle, N.C. 7/55	15,000		1, 2	100			1, 3, 4, 7
6. Albert Lea, Minn.	16,000		6		100		3, 4, 7
7. Albion, Mich.	13,000		1, 2		100		none
8. Albuquerque, N.M. 7/55	170,000		6		100		3
9. Alexandria, La. 6/55	54,000		7		100		3
10. Alhambra, Calif. 7/55	55,000		4		100		none
11. Allen Park, Mich.	35,000		4			100	none
12. Alliance, Ohio	31,000		1	100			1-4, 6
13. Amarillo, Tex. 10/55	130,000		6		100		3
14. Americus, Ga.	12,000		1, 2		100		4
15. Ames, Iowa	23,000		6		100		1-5
16. Anaheim, Calif.	45,000		2		100		
17. Annapolis, Md. 7/55	27,000		4		100		1-7
18. Anniston, Ala. 4/55	49,000	13,000	4		100		3
19. Ansonia, Conn.	18,000		pvt.	100			3
20. Antioch, Calif. 7/55	14,000		1-3	√		√	1, 3, 6, 7
21. Appleton, Wis.	40,000	1,000	4	100			1-4, 6, 7
22. Arcadia, Calif. 7/55	35,000		6		100		none
23. Arlington, Va. 7/55	163,000	37,000	9			100	
24. Asheville, N.C. 7/55	100,000	†	2	100			3, 4
25. Ashland, Ohio	16,000		1	50	50		2-4, 6
26. Athol, Mass.	12,000		4	100			1-3, 6, 7
27. Atlanta, Ga.	512,000	28,000	4	100			1, 3, 4, 6
28. Atlantic City, N.J.	*90,000		8	58	42		3
29. Auburn, Me.	19,000		5	100			3
30. Auburn, N.Y. 7/55	48,000		6	100			1, 3
31. Augusta, Ga.	150,000		1, 2, 4	100			1, 3, 7
32. Augusta, Me.	22,000		5	100			3, 4
33. Austin, Minn. 3/55	24,000		4		100		3, 4
34. Austin, Tex. 10/55	193,000	7,000	6	100			1-4
35. Baltimore, Md.	1,300,000		8	100			1, 3-5, 7
36. Bangor, Me.	32,000		4	100			1, 3
37. Barberton, Ohio	35,000			94	6		1, 3-6
38. Batavia, N.Y.	18,000		4	100			1-4, 6
39. Baton Rouge, La.	171,000		pvt.		100		3
40. Bay City, Mich. 7/55	60,000	4,000	2	100			1-3, 6, 7

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Pumping Power#			Distribution Storage¶					Distr. Pressure—psi				Distr. Temp.—°F	
	To Plant	To Sys-tem	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
				mil gal				days	Max.	Min.	Max.	Min.		
1	2	2	2	0.5	3.0		3.5	1.4	60	58	60	58	48	68
2	5	2		1.5	1.5		3.0	0.8	80	70	80	40	40	69
3	2, 5	1, 2	2	13.8	22.6		36.4	0.9	100	75	150	30	43	78
4		5				210.0	210.0	8.6	95	90	75	35	40	60
5	2	2		0.6	1.5		2.1	1.0	95	65	100	40	48	82
6	2	2, 5	2	1.0	1.5	1.5	4.0	2.7	47	42	47	35	52	54
7		2		0.1			0.1	0.0	65	50	65	45		
8	2	1, 2	2			31.0	31.0	1.3	95	80	100	50	72	72
9		2			3.2		3.2	0.7	65	60	65	55	72	72
10		2	2	0.1	27.0	5.0	32.1	3.9	90	40	125	40	68	68
11	2	2	2						60	40	50	30		
12	2	2	2	3.3			3.3	0.6	85	50	120	30	40	70
13	2	2, 3	2, 3	3.5	25.0		28.5	1.4	72	65	72	10	62	62
14	2	2		0.3	0.4		0.7		75	40	50	35	52	52
15	2	2	2	0.5	3.2		3.7	2.2	75	55	75	40	48	57
16		2, 4			3.0		3.0	0.5	65	50	65	50	65	67
17	2	2		0.5	1.8		2.3	1.4	54	48	54	48		
18		2	2			8.6	8.6	1.1	100	90	120	35		
19		2, 5	2						103		103		52	76
20	2	5	2	0.3		2.0	2.3	1.0	45		45		40	60
21	2	2		1.0	2.0		3.0	0.6	60	50	50	40	33	78
22		2	2			18.5	18.5	1.7	105	40	150	40		
23		2, 3	2	1.5	15.0		16.5	1.0	110	35	110	35		
24	3	3, 5	2			16.1			200	60	200	60		
25	2	2		2.0					90	75	100	10	40	70
26	5	2, 5		0.3	1.5	1.5	3.3	3.3	140	100	140	30	40	50
27	1	1	2	4.5	10.0	9.0	23.5	0.4	75	30	125	50	38	85
28	5	2		1.1			1.1	0.1	50	40	50	40	58	74
29		2		0.3		7.5	7.8	3.9	140	25	150	10	45	60
30	2	2		13.5			13.5	1.5	75		130	40	34	75
31	4	2, 5	2	1.1		8.0	9.1		75	57	75	57		
32	2, 5	2	2	0.9		16.0	16.9	5.3	140	100	100	20	35	60
33		1, 2	2	1.5	3.0	0.1	4.6	1.4	75	60	75	50	45	52
34	2	2	2	21.5	8.0		29.5	0.9	110	70	110	35	58	78
35	5	5	2	11.8		532.4	544.2	2.8	85	50	250	25	39	71
36	2	2		3.8			3.8	1.0	120	70	70	20	37	77
37	5	2		4.0			4.0	0.8	95	65	95	30	39	74
38	2	2		1.5	0.6		2.1	1.1	70	65	70	65	40	76
39		2		2.4	3.8		6.2	0.4	65	50	65	50	60	70
40	2	2		0.1			0.1	0.0	55	40	55	40	35	73

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
41. Beaver Falls, Pa.	65,000		5	100			1, 3, 5, 6
42. Beckley, W.Va.	50,000		pvt.	100			1, 3, 4, 6
43. Bellaire, Ohio	13,000		2	33	67		1, 3, 4, 6
44. Bellaire, Tex. <sup>10/88</sup>	22,000		2		100		3
45. Bellingham, Wash.	39,000		1, 4	100			3
46. Belmont, Mass.	30,000		4			100	
47. Bemidji, Minn.	10,000		2		100		
48. Benton Harbor, Mich.	22,000		6	100			1, 3, 7
49. Berlin, N.H.	18,000		4	✓	✓		1
50. Beverly Hills, Calif. <sup>7/88</sup>	43,000		2	✓	✓	✓	1-6
51. Bexley, Ohio <sup>11/88</sup>	14,000		1, 2			100	
52. Billings, Mont.	60,000		4	100			1, 3, 4, 6
53. Binghamton, N.Y.	95,000		7	100			1, 3, 6
54. Birmingham, Ala.	510,000		4	100			1, 3-5
55. Birmingham, Mich. <sup>7/88</sup>	23,000		6		50	50	
56. Bismarck, N.D. <sup>7/88</sup>	23,000		7	100			1-7
57. Bloomfield, N.J.	52,000		2, 3			100	
58. Bloomington, Ill. <sup>8/88</sup>	38,000		6	100			1-3, 6
59. Boone, Iowa	13,000		1, 2		100		3
60. Boston, Mass.	710,000		7			100	4
61. Boulder, Colo.	32,000		2	100			3
62. Braddock, Pa.	17,000		2				1
63. Bradenton, Fla.	14,000		2	100			1, 3, 4, 6
64. Bradford, Pa.	20,000		5	85	15		3
65. Brawley, Calif. <sup>7/88</sup>	14,000		2			100	1
66. Bremerton, Wash.	45,000	†	7	70	30		4
67. Bridgeport, Conn.	268,000		pvt.	85	15		3, 4
68. Bristol, Tenn. <sup>8/88</sup>	20,000		7	100			1, 3-7
69. Bristol, Va.	18,000	3,000	3	100			1, 3, 4, 6, 7
70. Brockton, Mass.	65,000	15,000	4	100			3
71. Brookline, Mass.	58,000		4			100	
72. Brownsville, Tex.	50,000		6	90	10		1, 3, 6
73. Buffalo, N.Y.	585,000		1, 3	100			1, 3, 6, 7
74. Burbank, Calif. <sup>7/88</sup>	92,000		6	10	90		
75. Burlington, Iowa	31,000	1,000	2	100			1, 3, 6
76. Burlington, N.J.	14,000		4		100		1, 3, 6
77. Burlington, N.C. <sup>7/88</sup>	30,000	1,000	6	100			1, 3-6
78. Butte, Mont.	56,000		pvt.	100			3, 4, 6
79. Cambridge, Ohio	18,000		1, 2	100			1-3, 6
80. Canton, Ohio	136,000		1		100		3, 5, 7

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power#				Distribution Storage¶					Distr. Pressure—psi				Distr. Temp.—°F	
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
							mil gal	days	Max.	Min.	Max.	Min.		
41	2, 4	2, 3	2	6.7		5.0	11.7	1.7	120	50	120	30		
42	2	2	2	2.5			2.5	1.1	80	70	100	40	35	70
43	2	2	2	0.3		1.5	1.8	0.8	68		45		41	77
44	2	2	2	0.8	1.5		2.3	0.9	65	60	65	40	60	60
45	5	5							100	90	100	40	47	66
46											160	30		
47		2, 5		0.1			0.1		65	50	65	50	42	48
48	2	2		0.6			0.6	0.2	75	70	70	50	32	75
49	5	5	2	0.2		45.0	45.2		120	75	165	50	33	65
50	2	2	2			27.0	27.0	3.1	140	45	140	45	68	72
51		2												
52	2	2	2	3.8		9.1	12.9	1.4	75	60	120	30		
53	2	2	2	0.3		10.7	11.0	1.1	87	75	95	20	33	81
54	1, 2	2	2	0.6		13.6	14.2	0.3	85	75	175	30	45	70
55	2	2		1.3			1.3	0.6			60	42	50	52
56	2	2	2	0.5		7.5	8.0	3.7	62	48	58	40	34	70
57		5							110	90	80	65		
58	2	2	2	0.8	15.0		15.8	3.2	60	50	80	40	34	78
59	2	2	2	1.0	3.0		4.0	2.5	60		70		45	70
60	5	5							90	30	90	30	35	75
61		5				33.7	33.7		140	100	200	55	35	55
62	2	2	2			15.4	15.4	8.1	120		110			
63	2	2	2	0.7	1.0		1.7	1.1	55	40	55	40	60	70
64		5	3	3.5					90	80	95	20	40	60
65	5	2		0.3			0.3	0.1	60	45	60	45	60	75
66		2	2	0.5	2.8	15.0	18.3	2.6	80	50	80	30		
67	2	2	2, 3						100	70	100	25	37	65
68	2	2				3.0	3.0	1.4	85	80	85	20	43	45
69	2	2	2			3.0	3.0	1.3	80	55	100	15	44	76
70	2, 3	2, 3	2	0.1		8.0	8.1		85	85				
71		5	2, 3	1.7		11.5	13.2	2.4	90	60	115	40	35	70
72	2	2	2	1.0	3.3		4.3	0.7	80	50	80	50	68	87
73	2	1, 2	2	6.0			6.0	0.0					33	70
74		2	2						165	40	165	40	61	63
75	2	2	2	0.6		2.4	3.0	0.7	110	90	110	20	36	78
76	2	2		0.7	0.3		1.0	0.5	52	48	52	48	55	59
77	2	2		1.7	6.0		7.7	1.7	70	50	95	45	45	75
78	1, 2	2	2						110	105	130	30	32	67
79	2	1, 2	2			2.5	2.5	0.9	112	65	108	35	48	70
80	2	2	2			15.0	15.0	0.7	75	72	90	30	55	58

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
81. Cape Girardeau, Mo.	24,000		pvt.	100			1, 3, 7
82. Carthage, Mo. <sup>7/55</sup>	12,000		3		100		1-3, 7
83. Cedar Falls, Iowa	17,000		1, 2		100		3
84. Cedar Rapids, Iowa	80,000		2	100			1-4, 6, 7
85. Chambersburg, Pa.	20,000		5	100			3, 4
86. Champaign, Ill.*	77,000		pvt.		100		1, 3, 5
87. Charleroi, Pa.	46,000		5	100			1, 3, 5, 6
88. Charleston, S.C.	145,000		4	100			1, 3, 4
89. Charleston, W.Va.	185,000		pvt.	100			1, 3, 4, 6, 7
90. Charlotte, N.C. <sup>7/55</sup>	180,000		2	100			1, 3, 4, 6, 7
91. Chicago, Ill.	4,428,000	*†	1, 2	100			*1, 3, 6
92. Clarksburg, W.Va.	43,000		4	100			1, 3, 4, 6, 7
93. Clarksdale, Miss. <sup>10/55</sup>	21,000		4		100		5
94. Cleburne, Tex. <sup>10/55</sup>	20,000		6		100		3
95. Cleveland, Ohio	1,280,000	180,000	1	100			1, 3, 7
96. Clinton, Iowa	28,000		pvt.		100		3
97. Cobb County, Ga.		75,000	5	100			1, 3, 6, 7
98. Coffeyville, Kan.	22,000		1, 2	100			1-4, 6, 7
99. Collinsville, Ill.	17,000		1		100		
100. Colorado Spgs., Colo.	75,000	15,000	6	88	12		1, 3
101. Columbia, Mo. <sup>10/55</sup>	40,000		6		100		3
102. Columbia, S.C. <sup>7/55</sup>	106,000		2	100			1, 3, 4
103. Columbia, Tenn. <sup>7/55</sup>	19,000		3	100			1, 3, 6
104. Columbus, Miss.	19,000		3	100			1, 3, 4, 6, 7
105. Concord, N.H.	28,000		6	100			3, 7
106. Corpus Christi, Tex. <sup>8/55</sup>	180,000		1, 2	100			1-3, 7
107. Coshocton, Ohio	16,000		1, 2		100		2, 3
108. Council Bluffs, Iowa	50,000		4	100			1-3, 6
109. Covington, Ky.	200,000	†	6	100			1, 3-6
110. Crawfordsville, Ind.	14,000		pvt.		100		1, 3, 5
111. Cudahy, Wis.	16,000		4	100			1, 3, 6
112. Cuyahoga Falls, Ohio	41,000	6,000	8		100		1-5
113. Dallas, Tex. <sup>10/55</sup>	585,000	37,000	2	95	5		1-4, 6
114. Danville, Va.	50,000		6	100			1, 3, 4, 6, 7
115. Dayton, Ohio	320,000		6		100		1-3
116. Dearborn, Mich. <sup>7/55</sup>	130,000		1, 2			100	
117. Decatur, Ala. <sup>5/55</sup>	26,000	2,000	4	100			1, 3
118. De Kalb, Ill. <sup>5/55</sup>	17,000		4		100		none
119. De Kalb County, Ga.	160,000		9	100			1, 3, 6, 7
120. Denison, Tex. <sup>3/55</sup>	21,000	4,000	2	100			1-3, 6

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power#				Distribution Storage¶				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To Sys-tem	Booster	El	G-P	G-G	Total	Bus. Dist.		Res. Dist.		Jan.	Jul.	
				mil gal				days	Max.	Min.	Max.			Min.
81	2	2	2			3.8	3.8	2.3	65	50	65	50	50	75
82	2	2, 5		1.5			1.5	1.6	80	50	80	50	56	73
83		2		0.8			0.8	0.5					52	52
84	2	2	2	0.3		8.0	8.3	0.8	80	65	80	15	33	80
85	1, 2	5		0.1		2.2	2.3	0.6	85	40	85	40		
86	2	2, 3	2	1.0	1.0		2.0	0.3	65	50	65	35	56	56
87	2	2, 5	2	3.5		10.0	13.5	2.3	140	110	90	60	69	71
88	1-3	1-3	2	3.5	3.0		6.5	0.4	45	32	100	32	40	80
89	2	2	2	12.6		2.1	14.7	0.7					38	82
90	2	2		3.2	11.8		15.0	0.8	120	40	120	40	48	84
91	2	1, 2							50	25	50	25	32	66
92	2, 4	2, 4				3.0	3.0	0.6	140	100	140	40	40	75
93	2	2		0.5			0.5	0.3	70	60	70	60	65	68
94		2	2	1.1	1.0		2.1	1.0	60	30	60	30	80	80
95	1, 2	1, 2	2	8.7	245.0		253.7	0.8	60	40	162	35	35	67
96	1, 3	1, 2	2	0.7	1.3		2.0		100	85	80			
97	2	2, 5	2			4.0	4.0	0.7					43	75
98	2	2				6.0	6.0		70	60	75	55		
99		2	2	0.2		0.1	0.3	0.2	67	65	55	50	50	55
100	2	5	2			33.6	33.6	1.4	90	60	200	40	36	56
101	2	2		1.0			1.0	0.4	90	60			57	68
102	2		2, 4	3.0			3.0	0.3					49	86
103	2	2		2.0			2.0	0.7	100	80	90	65	50	80
104	2	2		1.1	0.6		1.7	0.8	100	55	100	55	60	86
105		2, 5	2	0.6	2.0		2.6	0.7	88	48	100	30	39	70
106	2	2	2	2.8	36.0		38.8	1.0	65	40	50	30	52	83
107	2	2				3.3	3.3	1.4	115	85	115	80	55	55
108	2	2	2	0.2		4.0	4.2	0.8	90	60	130	60	34	77
109	2	5	2	0.6		4.0	4.6	0.5	110	80	110	50	41	86
110	2	2		0.3	0.7		1.0	0.8	55	50	60	45	51	55
111	1, 2	2		0.5	0.5		1.0	0.4	60	45	65	45	36	62
112	2	2, 5	2	2.6			2.6	0.8	70	60	70	60	55	55
113	5	2	2	9.0	58.2		67.2	0.7	90	60	90	30	48	83
114	2, 5	2	2	1.0		8.0	9.0	2.2	95	25	95	15	40	80
115	2	2	2	9.0	46.0	10.4	65.4	1.4	73	50	75	40	60	68
116				2.5			2.5	0.1						
117	2, 5	2, 5		3.3			3.3	0.7	62	58	60	55	40	80
118		2		0.8	0.5		1.3	0.7	65	55	65	45	56	56
119	2	2	2	6.3			6.3	0.3	75	50	150	45	45	74
120	2	2	2	0.5		1.0	1.5	0.6	68	55	125	40	49	60

§ Key: S—surface water; G—ground water; P—purchased water; ¶ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

TABLE 1 (contd.)

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
121. Denton, Tex. <sup>6/55</sup>	28,000		1		100		3
122. Denver, Colo.	550,000	64,000	4	81	19		1, 3, 7
123. Derby, Conn.	10,000		pvt.	√	√		3
124. Des Moines, Iowa	215,000	4,000	4	50	50		1-4, 6
125. Des Plaines, Ill.	25,000		2		100		2, 3
126. Detroit, Mich. <sup>7/55</sup>	1,910,000	1,147,000	4	100			1, 3, 6
127. Dodge City, Kan.	12,000		4		100		3
128. Dover, N.J.	13,000		4	10	90		3
129. Dubuque, Iowa	54,000		2		100		3, 5, 7
130. Duluth, Minn.	105,000	2,000	1	100			3, 6
131. Durant, Okla. <sup>7/55</sup>	13,000		5	100			1, 3
132. Durham, N.C. <sup>7/55</sup>	85,000		2	100			1, 3, 5, 6
133. Dyersburg, Tenn. <sup>7/55</sup>	13,000		2		100		3-5
134. E. Bay M.U.D., Calif. <sup>7/55*</sup>	1,000,000		5	100			1, 3, 4, 6
135. East Detroit, Mich. <sup>7/55</sup>	40,000		6			100	
136. East Jefferson, La.	85,000		4	100			1-4, 6
137. East Lansing, Mich. <sup>7/55</sup>	13,000				100		2-7
138. East Orange, N.J.	83,000		4		100		3
139. Eau Claire, Wis.	36,000		6		100		1, 3, 5, 7
140. Ecorse, Mich. <sup>7/55</sup>	21,000		1, 2			100	
141. El Centro, Calif.	16,000		2	100			1, 3
142. El Dorado, Kan.	16,000		6	√	√		1-7
143. Elizabeth, N.J.	130,000		4			100	
144. Elizabeth City, N.C. <sup>7/55</sup>	15,000		3		100		1-3, 5
145. Elmira, N.Y.	70,000		4				1, 3, 4, 6, 7
146. Elwood, Ind.	13,000				100		3
147. Emporia, Kan.	18,000		2	100			1-3, 6
148. Endicott, N.Y.	61,000		pvt.		100		3
149. Erie, Pa.	151,000		1, 2	100			1
150. Escanaba, Mich. <sup>7/55</sup>	15,000		2	100			1, 3, 4, 6, 7
151. Eugene, Ore.	44,000	25,000	4	100			1, 3
152. Evanston, Ill.	76,000	45,000	6	100			1, 3, 6, 7
153. Fargo, N.D. <sup>7/55</sup>	45,000		7	100			1-4, 6, 7
154. Faribault, Minn.	16,000		1, 2		100		3
155. Fayetteville, N.C. <sup>7/55</sup>	60,000		3	100			1, 3, 4, 6, 7
156. Fergus Falls, Minn. <sup>4/55</sup>	14,000		4	100			1-4, 6, 7
157. Flint, Mich. <sup>7/55</sup>	190,000		6	100			1-4, 6
158. Florence, Ala. <sup>10/55</sup>	29,000		4	100			1, 3
159. Fort Collins, Colo.	23,000		3	100			1, 3, 6
160. Fort Dodge, Iowa	30,000		1, 2		100		1, 3, 5

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‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Pumping Power #			Distribution Storage ¶				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	EI	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
									Max.	Min.	Max.	Min.		
mil gal							days							
121		2	2	2.6	1.0		3.6	1.2	75	35	75	35	62	73
122	5	5	2		15.0	126.0	141.0	1.6	83	54	125	30	49	63
123	2	2, 5	2						120	100	90	80	50	55
124	2	1, 2		8.0			8.0	0.3	120	90	105	35	47	68
125	2	2	2	1.2	1.2		2.4		55	45	55	45	50	55
126	2	1, 2	2	8.0	145.0		153.0	0.3	42	30	75	17	34	70
127		2	2	1.0			1.0	0.3	110	80				56
128	5	2	2			6.9	6.9	3.7	75	70	125	60		
129	2	2, 5	2	1.8	8.6	1.8	12.2	2.6	170	88	115	40	60	62
130	2	2, 5	2	1.1	4.5	65.7	71.3	4.5	110	80	140	30	36	48
131	2, 3	2	2	0.4			0.4	0.2	62	45	62	28		
132	2, 4	2		1.5	4.0	3.5	9.0	1.1	90	70	100	65	43	73
133	2	2			0.6	2.0	2.6	1.2	86	71	89	30	65	65
134	2	2, 5	2			502.4	502.4	4.0	130	40	130	40	51	66
135		2					0.0		75	40	75	40		
136	2	2, 3	2, 3	2.5	5.5		8.0	1.0	60	50	60	50		
137	2	2		0.5			0.5	0.4	50	40	50	40	52	55
138	2	2				10.0	10.0	1.4	90	70	97	60	50	65
139	2	2		3.0			3.0	0.3	125	90	135	65	50	52
140														
141	2	2		0.4		5.0	5.4	1.1	35	32	35	32		
142	2, 3	2, 5		0.4	0.5	0.6	1.5	1.4	70	40	70	40		
143									45	36	75	35	36	63
144	2	2		0.5			0.5	0.4	58	55	58	55	70	85
145	2	2, 5	2		3.5	8.5	12.0	1.5	80	70	80	20	36	78
146	2	2		0.5			0.5	0.7						
147	2	2	2	3.0			3.0	1.7	60	40	70	30	38	78
148		2, 3	2	6.0			6.0	0.7	100	90	60	55	51	55
149	2	2	2	1.6		43.0	44.6	1.2	65	40	95	40	38	71
150	2	2		0.5	1.0		1.5	1.0	65	55	60	50	35	55
151	2	2	2	22.6			22.6	2.1	100	70	145	25	42	57
152	2	2		2.5	9.0		11.5	0.6	60	45	60	30		
153	2	2	2	2.0	1.0		3.0	0.6	60	55	60	55	37	77
154	2	2, 5		1.0		3.0	4.0	2.8	100	100	120	70	50	56
155	2	2		3.0			3.0	0.8	75	55	120	85		
156	5	2				2.2	2.2	1.4	75	65	65	45	33	70
157	2	2	2	2.0	10.0		12.0	0.3	63	46	69	23	38	80
158	2	2		2.0			2.0	0.9	80	50	100	40		
159		5				10.0	10.0	1.8	90	60	80	60	50	56
160	2	2		1.5	2.0		3.5	0.9	60	50	100	35	58	60

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.  
 || Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal;  
 6—taste and odor control; 7—fluoridation.

\* Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).  
 ¶ EI—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
161. Fort Madison, Iowa	15,000		4	100			1, 3
162. Fort Scott, Kan.	10,000		7	100			1-3, 6, 7
163. Fort Wayne, Ind.	140,000		1, 3	100			1-3, 5-7
164. Fostoria, Ohio	16,000		1, 2	100			1-4, 6
165. Frankfort, Ky. <sup>7/55</sup>	20,000		3	100			1, 3, 4
166. Franklin, Ind.	10,000		pvt.	100			1, 3, 5
167. Franklin, Pa.	14,000		1	67	33		1, 3
168. Fredericksburg, Va. <sup>7/55</sup>	15,000		2	100			1, 3, 4, 6, 7
169. Freeport, Ill. <sup>10/55</sup>	32,000		4		100		1, 3, 5
170. Fremont, Neb.	18,000		3		100		
171. Fresno, Calif. <sup>7/55</sup>	130,000		2		100		none
172. Fullerton, Calif. <sup>7/55</sup>	41,000		2		55	45	
173. Fulton, Mo. <sup>7/55</sup>	12,000		1, 2		100		
174. Gainesville, Ga.	20,000		6	100			1, 3, 4, 6, 7
175. Garden City, N.Y. <sup>3/55</sup>	21,000		4		100		4
176. Gary, Ind.	183,000		pvt.	100			1, 3, 4, 6
177. Gastonia, N.C. <sup>7/55</sup>	51,000	6,000	2	100			1, 3, 6
178. Glen Cove, N.Y.	20,000		pvt.		100		3
179. Glendale, Calif. <sup>7/55</sup>	112,000		2		94	6	3, 4
180. Gloversville, N.Y.	24,000		4	100			1, 3-7
181. Goldsboro, N.C.	30,000		6	100			1, 3, 4, 6
182. Goshen, Ind.	13,000		3		100		none
183. Grand Island, Neb. <sup>8/55</sup>	25,000		1, 2		100		none
184. Grand Junction, Colo.	25,000		2	100			1, 3, 7
185. Grand Rapids, Mich. <sup>7/55</sup>	196,000		6	100			1-3, 6, 7
186. Great Bend, Kan.	21,000		pvt.		100		3
187. Green Bay, Wis.	60,000		4		100		3
188. Greensboro, N.C. <sup>7/55</sup>	92,000		2	100			1, 3, 4
189. Greenville, Miss. <sup>10/55</sup>	40,000		1, 2		100		3
190. Greenville, N.C. <sup>7/55</sup>	18,000		4	75	25		1, 3, 6
191. Greenville, S.C. <sup>8/55</sup>	165,000	†	3	100			3, 4, 6
192. Greenwood, Miss. <sup>10/54</sup>	19,000		4		100		3
193. Greenwood, S.C.	23,000		3	99	1		1, 3, 4, 6
194. Griffin, Ga. <sup>12/54</sup>	25,000		6	100			1, 3, 4, 6, 7
195. Haddonfield, N.J.	12,000		7		100		1, 5
196. Hagerstown, Md.	49,000	4,000	4	66	34		1, 3, 4, 6, 7
197. Hamilton, Ohio	70,000		8		100		1-5, 7
198. Hammond, Ind.	100,000	26,000	4	100			1, 3, 4, 6, 7
199. Hannibal, Mo. <sup>6/55</sup>	21,000		3	100			1, 3, 6, 7
200. Hanover, Pa.	23,000		4	100			1, 3, 6

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Pumping Power #				Distribution Storage¶				Distr. Pressure—psi				Distr. Temp.—°F			
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.	
				mil gal					days	Max.	Min.	Max.			Min.
161	2	2	2			1.0	1.0	0.9	70		70		36	84	
162	2	2, 5	2												
163	2	2		2.0	24.8		26.8	1.3	75	60	75	25	36	79	
164	2	2, 3		1.9		0.5	2.4	1.5	85	65	65	20			
165	2	2, 5	2	0.2		7.0	7.2	3.3	125	120	125	40	40	75	
166	2	2		0.1	0.6		0.7	0.7	60	50	65	45	52	54	
167	2	2	2	0.1		2.6	2.7	1.3	85	80	150	20			
168	2	2	2	0.1		3.3	3.4	0.8	45	40	50	20	40	80	
169	2	2		0.1	0.8	1.0	1.9	0.8	86	72	88	30	52	57	
170		2							75		75		58	58	
171		2		1.9			1.9	0.0	50		50		68	72	
172		2, 5	2	0.1	14.0		14.1	1.7	67	55	110	70	65	67	
173		2, 5		0.2	0.2		0.4	0.6	62	50	62	50			
174	2	2	2	0.5	0.1		0.6	0.2	85	70	125	60	43	79	
175		2	2	1.0	2.0		3.0	0.8	75	65	75	65			
176	2	2	2	3.3			3.3	0.1	75	60	65	35	35	65	
177	2	2	2	1.0	2.8		3.8	0.8	80	60	70	50			
178	2	2		0.5			0.5	0.3	100	90	50	40			
179	2	2	2			173.1	173.1	8.1	210	35	210	35	67	69	
180	4	5		5.3			5.3	1.8	90	40	90	40	34	72	
181	2	2		2.0	0.6		2.6	1.2	55	50	50	45	42	77	
182		2, 3		0.8			0.8		60		60	50	54	58	
183		2	2			4.0	4.0	0.3	75	50	75	50	56	62	
184		5							100	80	100	40			
185	2	1, 5	2	3.8		43.2	47.0	1.4	120	40	90	35	33	60	
186		2		0.4			0.4	0.2	80	60	80	50	62	69	
187		2	2	1.0	3.5		4.5	0.6	60	50	60	50	53	53	
188		3	3	2.2	21.0		23.2	2.3	81	62	101	43	50	85	
189	2	2	2	0.5	0.3		0.8	0.2	60	50	60	50	62	62	
190	2	2, 5		1.2	0.5		1.7	1.5	70	65	70	65	42	78	
191	2, 5	5		1.7		139.0	140.7	8.7	95	70	135	50	46	75	
192	2	2		0.1	1.0		1.1	0.3	65	40	65	40	70	72	
193	2	2		0.8	2.0		2.8	1.5	90	70	90	50	45	82	
194	2	2		1.3	4.5		5.8	1.9	60	40	60	40	47	77	
195	2	2		0.4			0.4	0.4	58	40	58	28	25	75	
196	2	2, 5	2		0.2	11.5	11.7	1.7	66	56	110	17	40	75	
197	2	2	2	0.2		11.5	11.7	1.8	95	80	110	50	57	58	
198	2	1	2	6.5			6.5	0.3	50	40	70	35	33	70	
199	2	5		0.1		7.5	7.6	4.4	100	60	100	40	40	78	
200	5	2, 5	2	0.1		13.0	13.1	7.0	75	50	75	50	35	72	

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

\* Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency‡	Source of Supply —per cent§			Type of Treatment
	Retail	Wholesale		S	G	P	
201. Harlingen, Tex.	33,000		4	88	12		1, 3, 4, 6
202. Hartford, Conn.*	340,000	4,000	5	100			1, 3
203. Hastings, Neb.	25,000		3		100		3
204. Haverstraw, N.Y.	11,000		pvt.	64	36		1, 3, 4
205. Helena, Ark.	11,000		4		100		3, 4, 6, 7
206. Hibbing, Minn.	21,000		4		100		3
207. Highland Park, Mich. <sup>7/88</sup>	46,000		1, 2	100			1, 3, 6, 7
208. Hilo, T.H.*	33,000		4	√	√	√	*
209. Holland, Mich.	19,000				100		3, 4
210. Hollywood, Fla. <sup>10/88</sup>	*50,000		6		100		2-5
211. Honolulu, T.H.	260,000		4		100		*3
212. Hopkinsville, Ky. <sup>8/88</sup>	20,000		4	100			1, 3, 4, 6, 7
213. Hoquiam, Wash.	13,000		1, 2	100			3
214. Hot Springs, Ark.	33,000		4	100			1, 3, 4, 6
215. Houston, Tex.	725,000		1, 2	20	80		1, 3, 4, 6
216. Huntington Pk., Calif. <sup>7/88</sup>	30,000		1, 2		100		none
217. Hutchinson, Kan. <sup>2/88</sup>	38,000		pvt.		100		3
218. Independence, Kan.	15,000		7	100			1, 3, 6, 7
219. Independence, Mo.	69,000	1,000	pvt.	70	30		1, 3, 5
220. Indianapolis, Ind.	517,000		pvt.	99	1		1, 3, 6, 7
221. Ironton, Ohio <sup>2/88</sup>	16,000	2,000	6	100			1, 3, 4, 6, 7
222. Ithaca, N.Y.	34,000		3	100			1, 3
223. Jackson, Mich. <sup>7/88</sup>	55,000		6		100		3, 7
224. Jacksonville, Fla.	300,000		4		100		3, 6
225. Jacksonville, Ill.	25,000		4	100			1-3, 6, 7
226. Jamaica, N.Y.	548,000		pvt.		100		4, 5
227. Jamestown, N.Y.	50,000		3		100		3, 4
228. Janesville, Wis.	30,000		2		100		3, 7
229. Jefferson City, Mo.	28,000		pvt.	100			1-3
230. Jeffersonville, Ind.	26,000		pvt.		100		3
231. Johnson City, N.Y. <sup>8/88</sup>	26,000		4		100		3
232. Johnstown, N.Y.	11,000		2		100		3
233. Jonesboro, Ark.	18,000	2,000	3		100		3, 7
234. Junction City, Kan.	16,000		6		100		1-3, 5, 7
235. Kalamazoo, Mich.	83,000		6		100		3, 7
236. Kankakee, Ill.	49,000		pvt.	100			1-4, 6
237. Kansas City, Mo. <sup>8/88</sup>	712,000		2	100			1-6
238. Kearney, Neb.	13,000		6		100		none
239. Kennewick, Wash.	20,000		6	99	1		3
240. Kenosha, Wis.	60,000		6	100			1, 3, 6

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
	Pumping Power#			Distribution Storage¶					Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	El	G-P	G-G	Total	Bus. Dist.		Res. Dist.		Jan.	Jul.		
				mil gal				days		Max.	Min.			Max.	Min.
201	2	2		0.7	1.0		1.7	0.3	70	60	65	42	80	85	
202		5		1.3		14.5	15.8	0.4	115	85	95	15	39	63	
203	2	2			1.5		1.5	0.3	70	50	70	50	54	55	
204	2	2, 5	2	0.6		1.3	1.9	1.7	85	80	90	40			
205	2	2, 5	2	0.1	0.5	1.0	1.6	1.5	55	55	55	35	70	70	
206		2		0.4	4.0		4.4	1.5	78	77	78	77	46	48	
207	2	2	2	0.3		3.0	3.3	0.3	45	40	45	40	34	70	
208		*		0.1	0.5	24.4	25.0		90	70	120		74	76	
209		2		0.8	0.8		1.6	0.6	60	40	60	40	55	60	
210	2	2	2	0.3	2.0		2.3	0.6	64	60	64	60	62	62	
211		1, 2	2			27.2	27.2	0.7	80	70	150	35	72	72	
212	2	2		0.8			0.8	0.5	90	85	80	50	42	76	
213	2	2							100		100	40			
214	2, 5	2, 5			0.6	1.8	2.4	0.8	110	90	165	50	46	83	
215	2-4	1-4	1-4	2.1	60.4		62.5	0.8	90	60	50	40	86	85	
216		2	2	0.2	9.4		9.6	2.2	52	48	52	48	68	68	
217		2							70	55	60	45	58	62	
218	2	2, 3	2, 3		1.0		1.0	0.7					45	90	
219	2	2, 3	2, 3	1.3	2.0		3.3	0.7	55	40	140	35	34	70	
220	2, 4	1, 2	2	3.0			3.0	0.1	60	50	130	30	38	78	
221	2	5		6.0			6.0	4.4					40	78	
222	5	2, 5	2	4.3		1.5	5.8	1.8	90	80	165	20	34	71	
223		5	2	3.0	3.0		6.0	0.5	75	70	75	35	52	56	
224	2	2		3.5		19.0	22.5	0.7	60	60	60	40	78	80	
225	2, 5	2	2	2.0			2.0	0.9	85	80	60	40	34	70	
226		2	2	12.3	15.7		28.0	0.6	65	50	60	30			
227		1	2			6.5	6.5	1.3	140	30	140	30	50	50	
228		2, 5				9.0	9.0	1.6					52	52	
229	2	2	2		1.2		1.2	0.8	100		120	50			
230	2	2		0.2	0.5		0.7	0.3	50	42	65	42	52	55	
231		2				4.0	4.0	0.6	100	70	100	25	52	54	
232		5							120	65	130	65			
233	2	2	2	1.5	1.3		2.8	1.6	80	65	70	50	65	71	
234	2	2	2		0.5	2.0	2.5	1.4	80	65	80	70	55	65	
235		2		2.2		7.0	9.2	0.9	60	50	100	40	55	65	
236	2	2	2	0.9	1.3		2.2	0.2	85	60	85	50	40	70	
237	2	2	2	2.5	45.0		47.5	0.5	165	45	165	45	40	85	
238		2	2			1.0	1.0	0.5	55	45	55	45	54	56	
239	2	2, 5	2	0.4	0.5	2.0	2.9	0.6	90	70	120	30	35	65	
240	2	2	2			2.8	2.8	0.3	70	40	70	20	36	61	

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

\* Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
241. Kent, Ohio	12,000		1		100		1-6
242. Keokuk, Iowa	16,000		4	100			1-3, 6, 7
243. Key West, Fla. <sup>9/55*</sup>	40,000		5		100		1-3
244. Kirksville, Mo.	12,000		1, 2	100			1, 2, 4, 6
245. Klamath Falls, Ore.	23,000		pvt.		100		3
246. Knoxville, Tenn.	170,000		4	100			1, 3, 4
247. Laconia, N.H.	14,000		pvt.	100			3
248. La Crosse, Wis.	48,000		3		100		3
249. Lafayette, La. <sup>10/55</sup>	38,000		3		100		1-6
250. Lake Worth, Fla. <sup>11/55</sup>	*23,000				100		3
251. Lakeland, Fla. <sup>9/55</sup>	48,000		2		100		3, 6
252. Lakewood, Ohio	70,000		1, 2			100	none
253. La Mesa, Calif.*	68,000		4	35		65	3
254. Lancaster, Ohio	29,000		1		100		1-5
255. Laredo, Tex.	64,000		4	100			1, 3, 5
256. Las Cruces, N.M. <sup>7/55</sup>	20,000		6		100		3
257. Las Vegas, Nev. <sup>7/55</sup>	47,000		5	19	81		3
258. Latrobe, Pa. <sup>4/55</sup>	20,000		5	100			1-3, 6
259. Lawrence, Kan.	25,000		6	75	25		1-7
260. Leavenworth, Kan.	24,000		4	100			1-3, 6
261. Lebanon, Pa.	55,000		1, 2	100			1, 3-6
262. Lewiston, Idaho <sup>7/55</sup>	13,000		1, 2	75	25		1, 3, 7
263. Lewistown, Pa.	25,000		5	100			3, 6
264. Lima, Ohio	72,000		1	√	√		1-4, 6
265. Lincoln, Neb. <sup>9/54</sup>	126,000		1, 2		100		1, 3, 5
266. Lincoln Park, Mich. <sup>7/55</sup>	48,000		1, 2			100	none
267. Little Rock, Ark.	136,000	65,000	4	100			1, 3, 4, 6, 7
268. Logansport, Ind.	25,000		3	100			1, 3, 7
269. Long Beach, Calif. <sup>7/55</sup>	288,000		4		64	36	1-3, 6
270. Long Island, N.Y.*	208,000		pvt.		100		1, 3, 4
271. Longview, Wash.	30,000		1	100			1, 3
272. Lorain, Ohio	63,000	4,000	8	100			1, 3, 4, 6, 7
273. Los Angeles, Calif. <sup>7/55</sup>	2,235,000		4	76	24		3
274. Louisville, Ky.	500,000	50,000	4	100			1-4, 6, 7
275. Lynchburg, Va. <sup>7/55</sup>	57,000		2	100			1, 3, 4, 7
276. Madison, Wis.	117,000	6,000	4		100		3, 7
277. Manchester, Conn.	24,000		4	81	19		1-3
278. Manchester, N.H.	87,000		4	100			3
279. Manhattan, Kan.	21,000		2		100		1-7
280. Manhattan Beach, Calif. <sup>7/55</sup>	32,000	1,000	6		30	70	3

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‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power <sup>§</sup>				Distribution Storage <sup>¶</sup>				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
							mil gal	days	Max.	Min.	Max.	Min.		
241	2	2		0.4			0.4	0.3					52	60
242	2	2		1.0			1.0	0.4	90	75	80	43	40	90
243	2, 3	2, 3	2	0.2	2.0		2.2		55	30	55	30	80	80
244	2	2, 5	2	0.5	0.6	8.0	9.1							
245		2	2			3.7	3.7	0.8	95	80	115	25	67	67
246	2	2	2	0.5		15.0	15.5	0.8	100	80	120	20	41	70
247		2		0.5		2.9	3.4	3.5	87	80	93	30	45	65
248		2, 5			1.0	5.0	6.0	0.7	100		100		56	56
249	2	2		1.0	1.8		2.8	0.7	70	60	70	60	73	78
250	2	2, 5	2	0.6			0.6	0.2	70		55		70	75
251	2	2		0.8	1.2		2.0	0.3	65	45	60	35	80	85
252		2, 5					0.0	0.0	50	35	85	40		
253		2, 5	2			126.0	126.0	9.2	100	40	210	25		
254	2	2	2			2.3	2.3	0.9	115	80	115	80		
255	2	2	2	4.2	1.4		5.6	0.8	76	50	76	49	57	83
256		2, 5				3.0	3.0	0.7	67	40	67	8		
257		2	2	0.3	3.7	30.0	34.0	2.0	70	40	100	40		
258	2, 3	2		1.0	10.0		11.0	2.5	130	90	125	55	41	59
259	2	2	2	0.5		2.4	2.9	0.9	95	75	125	40	38	75
260	2	2				5.0	5.0	2.3	140	120	140	120	38	86
261	1-3	1-3	2			371.1	371.1		90	50	90	40	40	72
262	2	2	2			9.9	9.9	3.6	105	40	100	15	37	68
263		5	2			13.0	13.0		72	68	80	40	38	68
264	2	1, 2							80	60			36	76
265	2	2	2	0.3		33.0	33.3	1.6	70	60	105	60	58	58
266		5											33	68
267		2, 5	2	0.6			0.6	0.0	80	60	220	35	52	65
268	2	2	2	3.5			3.5	1.2	82	65	75	58	38	82
269	2	2, 5	2			100.0	100.0	2.7	75	70	90	50	70	78
270	2, 3	3		0.5	11.7		12.2	0.8	70	50	70	50	54	54
271	2	2	2			7.0	7.0	2.8	100		100		46	58
272	2	2				4.0	4.0	0.5	60	55	60	40	45	72
273		5	2			18.2	18.2	0.0	85	65	100	40		
274	1, 2	1, 2	2	32.5			32.5	0.4	90	70	90	50	42	84
275		5	2	3.2		7.3	10.5	1.7	130	40	100	20	40	68
276	2	1, 2	2	9.2	4.2		13.4	0.9	90	65	85	50	56	56
277		2, 5	2	0.2			0.2	0.1	80	25	130	25	50	55
278		2, 3				34.0	34.0	3.0	95	40	146	10	40	70
279	2	2	2	1.6	0.4	0.6	2.6	0.9	110	75	90	35	56	58
280		5	2	0.4		2.4	2.8	0.8	85	60	80	40	62	65

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

¶ Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

\* Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
281. Manitowoc, Wis.	30,000		4		100		3
282. Marinette, Wis.	14,000		4	100			1, 3, 7
283. Marshalltown, Iowa	21,000		4		100		1-3, 5
284. Mason City, Iowa	32,000		1, 2		100		3, 6
285. Massillon, Ohio	38,000		pvt.	33	67		1-4, 6
286. McKinney, Tex. <sup>2/55</sup>	15,000	1,000	2		100		3, 5
287. Meadville, Pa.	20,000		1, 2		100		3
288. Medford, Ore. <sup>7/55</sup>	22,000	8,000	4		100		3
289. Memphis, Tenn.	500,000		4		100		1, 5
290. Menasha, Wis.	15,000		4	100			1, 3, 6, 7
291. Meriden, Conn.	42,000		1, 3	90	10		1, 3
292. Merrick, N.Y.*	155,000		pvt.		100		3, 4
293. Mesa, Ariz. <sup>7/55</sup>	29,000		1, 2		100		3
294. M.W.D. So. Calif. <sup>7/55</sup>		*	5	100			1-3, 6
295. Miami, Fla. <sup>7/55</sup>	318,000	182,000	4		100		1-4, 7
296. Michigan City, Ind.	31,000	4,000	4	100			1, 3, 6, 7
297. Middletown, Conn.	25,000		4	100			3
298. Midland, Mich. <sup>7/55</sup>	22,000	2,000	6	100			1-4, 7
299. Milford, Mass.	15,000	1,000	pvt.	95	5		1, 3, 4
300. Milwaukee, Wis.	699,000	98,000	7	100			1, 3, 6, 7
301. Minneapolis, Minn.	540,000	24,000	2	100			1-3, 6
302. Mishawaka, Ind.	33,000		3		100		3
303. Missoula, Mont.	30,000		pvt.	90	10		3
304. Mobile, Ala.	160,000		4	100			1, 3
305. Modesto, Calif. <sup>7/55</sup>	30,000		2		100		none
306. Monroe, Mich. <sup>7/55</sup>	25,000		2	100			1, 3, 4, 6, 7
307. Monroe, N.C. <sup>7/55</sup>	12,000	3,000	6	100			1-6
308. Monterey Park, Calif. <sup>7/55</sup>	30,000		2		100		3
309. Moorhead, Minn.	20,000		4		100		1, 2, 5
310. Mount Vernon, N.Y.	75,000		1	100			3
311. Murfreesboro, Tenn.	17,000		6	70	30		1-7
312. Nacogdoches, Tex. <sup>4/55</sup>	15,000		7		100		3, 4
313. Nashua, N.H.	35,000		pvt.	10	90		3
314. Nashville, Tenn.	234,000	70,000	1, 2	100			1, 3, 4, 6, 7
315. Natick, Mass.	27,000		3		100		5
316. Naugatuck, Conn.	19,000		pvt.	95	5		3, 4
317. Neenah, Wis.	15,000		4	100			1-3, 6, 7
318. New Albany, Ind.	40,000		pvt.	100			1, 3, 6
319. New Bedford, Mass.	124,000		4	100			3
320. New Haven, Conn.	302,000		pvt.	100			1, 3, 4

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power #				Distribution Storage †				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
				mil gal				days	Max.	Min.	Max.	Min.		
281		2		1.5	2.8		4.3	0.9	80	75	80	60	45	65
282	2	3	2, 3	0.4	0.5		0.9	0.4	60	50	60	50	34	63
283	2	2		1.1			1.1	0.5	75	50	75	25	63	65
284	2	1, 2		1.0	5.0		6.0	1.6	75	65	40	35	52	58
285	2	2	2	0.7		1.5	2.2	0.8	100	75	100	30	45	60
286	2	2	2	0.7	0.6		1.3	0.9	65	47	62	47	51	90
287		2	2	0.2		4.5	4.7	2.0	110	90	140	20		60
288		5	2			12.4	12.4	1.5	100	55	105	20	43	55
289	2, 4	1, 2			63.0		63.0	1.1	80	70	70	60	69	72
290		2		0.5	0.9		1.4	0.4	65	60	65	55		
291	5	2, 5	2	5.0			5.0	0.9	100	60	130	30		
292	2	2, 3		0.3	2.0		2.3	0.3	50	35	80	35		
293	2	2	2	0.3	10.0		10.3	2.5	62	50	62	50		
294	2	5											52	73
295	2, 3	2, 3	1, 2	2.0	22.5		24.5	0.3	70	60	90	35	74	75
296	2	2		1.8	1.5		3.3	0.4	68	50	54	30	33	78
297	2	2, 5		1.0			1.0	0.5	140	80	140	70		
298	2	2, 3		0.5			0.5	0.1	55	50	55	50	45	66
299	5	3	2	1.2			1.2	1.3	100	90	125	10		
300	2	1, 2	2	4.0	18.0	25.0	47.0	0.3	65	40	100	20	35	55
301	2	2, 5	2	3.0	77.0	40.0	120.0	2.0	75	20	75	20	35	75
302	2	1, 2		3.0	1.5		4.5	0.9	75	65	75	65	54	60
303						4.0	4.0	0.3	75	70	80	50	33	54
304	2	2, 5		0.1		20.0	20.1	1.4	84	50	84	50	50	84
305		2, 4		0.8			0.8	0.1	55	55	55	55	66	66
306	2	2	2	0.5	3.0		3.5	1.4	45	43	45	38	35	76
307	2	2		0.8	1.0		1.8	1.5	76	70	76	70	50	75
308		2	2			6.3	6.3	1.6	80	70	90	40	60	75
309	2	2	2	0.7	1.0		1.7	0.9	55	40	55	40	34	40
310		5							105	75	75	40	40	60
311	2	2		1.0			1.0	0.8	62	60	62	60	57	69
312	2	2		0.9	0.5		1.4	1.0	90	75	90	40	65	85
313		2-4		2.8			2.8	0.7	65	55	90	20		
314	2	2	2		2.8	56.7	59.5	1.9	100	55	100	25	57	82
315		2				4.3	4.3	1.5	70	45	90	45		
316	2	5	2	0.7			0.7	0.1	100	70	100	20	40	70
317	2	2		0.9	1.5		2.4	1.3	60		60		36	70
318	2	5	2	1.0		24.2	25.2		78	62	78	46	38	74
319		2, 3	2	0.3		63.0	63.3	3.1	90	40	85	25	37	70
320		2, 3	2	6.3		6.4	12.7	0.3	62	45	100	20	39	71

‡ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

† El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
321. New Iberia, La.*	60,000		pvt.				
322. New Orleans, La.	629,000		4	100			1-4, 6
323. New Rochelle, N.Y.	139,000		pvt.	20		80	1, 3, 4, 6
324. New York, N.Y.	7,650,000		4	100	*		3, 6
325. Newport Beach, Calif. <sup>7/55</sup>	20,000		2		√	√	3
326. Newport News, Va.*	200,000		4	100			1, 7
327. Newton, Iowa	14,000		4		100		3
328. Newton, Kan.	13,000	1,000	7		100		3
329. Niagara Falls, N.Y.	120,000		6	100			1, 3, 6
330. Niles, Ohio	21,000		2			100	none
331. Norfolk, Neb.	13,000		1, 2		100		1, 5
332. Norfolk, Va.	355,000	5,000	9	100			1, 3-7
333. North Miami, Fla.	43,000		1, 2		100		1-3
334. North Platte, Neb.	16,000		3		100		3
335. Norwich, Conn.	37,000		4	100			3
336. Oak Park, Ill.	64,000		1			100	3, 7
337. Oak Ridge, Tenn.	32,000		9	100			1, 3, 7
338. Ocala, Fla. <sup>10/55</sup>	14,000		2		100		1-4
339. Oceanside, Calif. <sup>7/54</sup>	23,000		6		50	50	
340. Oklahoma City, Okla. <sup>7/55</sup>	299,000		6	98	2		1-4, 6, 7
341. Olean, N.Y. <sup>8/55</sup>	23,000		1, 2	100			1, 3, 4, 6, 7
342. Omaha, Neb.	290,000		5	100			1, 3, 4, 6
343. Oneonta, N.Y.	20,000		4	100			1, 3, 4
344. Ontario, Calif.	40,000		6	14	86		3
345. Orange, Calif. <sup>7/55</sup>	20,000		2		95	5	none
346. Orlando, Fla.	105,000		3	40	60		1, 3
347. Oskaloosa, Iowa	12,000		3	60	40		1-4, 6
348. Ossining, N.Y.	16,000		4	100			1-4, 6
349. Ottawa, Kan.	11,000		7	100			1-3, 6, 7
350. Ottumwa, Iowa	35,000		4	100			1-3
351. Owatonna, Minn. <sup>3/55</sup>	12,000		3		100		3
352. Oxnard, Calif. <sup>8/55</sup>	29,000		2		100		3
353. Painesville, Ohio	16,000	24,000	6	100			1, 3, 4, 6
354. Palo Alto, Calif. <sup>7/55</sup>	49,000		6		50	50	3, 7
355. Paris, Tex. <sup>7/55</sup>	24,000		6	100			1, 3, 5, 7
356. Pasadena, Calif. <sup>7/55</sup>	133,000		6	5	33	62	3
357. Pasco, Wash.	14,000		1, 2	100			1, 3
358. Passaic Valley Com., N.J.*	285,000	115,000	4	100			1, 3, 4, 6
359. Peekskill, N.Y.	22,000		4	100			1, 3, 6
360. Pendleton, Ore. <sup>7/55</sup>	14,000		2	38	62		3, 7

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

## Physical Data, 1955

Physical Data, 1955

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power #				Distribution Storage ¶				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
				mil gal			days	Max.	Min.	Max.	Min.			
321														
322	2	2	2		35.0		35.0	0.3	62	60	61	47	46	83
323	2, 3	2, 3	2	1.8		4.5	6.3	0.4	100	70	130	20	45	65
324		5	2, 4			3,500.0	3,500.0		80	35	80	35	36	64
325	2	5	2			4.5	4.5	1.3	54	50	85	75	60	70
326		2		2.2	3.5		5.7	0.4	65	50	65	50	40	81
327	2	2		0.6	3.0		3.6	1.9	55	54	56	50	54	56
328	2	2	2	0.6	3.6		4.2	2.0	70	45	70	40	51	59
329	2	2		2.0			2.0	0.0	75	60	55	45	35	70
330	2	2				1.5	1.5	0.3	110	90	90	30		
331	2	2	2	0.7	0.8		1.5	0.8	85	80	85	70	54	54
332	2	2	2	2.0			2.0	0.1	65	55	65	40	48	79
333	2	2	2	0.1	3.0		3.1	0.7	80	60	60	50	80	80
334		2							65	50	75	50		
335	2	2, 5	2						120	110	80	70		
336	2	2	2		5.0		5.0	0.8	48	42	48	42	39	69
337	2	2, 5	2	0.3		10.2	10.5				120	35		
338	2	2	2	0.7	0.6		1.3	0.6	76	72	86	55	68	72
339														
340	2, 5	2	1	10.5	25.0		35.5	1.3	80	72	110	35		
341	2	2				10.4	10.4	3.9	90	70	100	40		
342	1, 2	1, 2	1, 2		49.0		49.0	0.8	125	25	155	50	33	81
343		2, 5	2	2.0			2.0	0.8	68	65	84	33	42	64
344	2	2, 5	2			18.0	18.0	2.3	120	90	150	40		
345		2	2	0.3	1.8		2.1	0.8	64	60	90	25	60	60
346	2	2		2.5	5.5		8.0	0.6	70	55	70	20	75	90
347	2	2, 5		1.0			1.0	0.9	50	43	46	42	48	68
348	2	2	2	0.5		12.0	12.5	10.1	85	68	125	20	40	65
349	2	2		0.8	0.9		1.7	1.4	70	40	70	40		
350	2	2	2	0.4		11.2	11.6	3.1	75	65	100	25	48	78
351		2	2	0.6			0.6	0.3	60	50	60	35	55	55
352	2	2	2	1.0		0.3	1.3	0.3	60	40	60	40	68	68
353	2, 3	2, 3				1.0	1.0	0.3	65	55	55	50	38	70
354	2	2	2		1.0	4.0	5.0	0.6	70	40	70	40		
355	2, 5	2, 3	2	0.8	2.0		2.8	1.1	75	30	50	10	60	85
356	2	2	2		4.8	101.0	105.8	4.1	100	35	180	25	56	72
357	2	2		0.6	0.3	5.0	5.9	1.5	60	45	70	35	36	66
358	5	2	2	0.3		250.0			110	70	80	35	36	70
359	2	5	2	0.8		3.0	3.8	0.8	185	35	185	35	37	74
360	2	5	2			4.3	4.3	1.2	100	80	80	40	42	48

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal;

6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
361. Phenix City, Ala.	24,000		4	100			1, 3
362. Philadelphia, Pa.	2,200,000		9	100			1, 3, 4, 6, 7
363. Phila. Sub. Wtr. Co., Pa.*	555,000		pvt.	100			1, 3, 4, 6
364. Phoenix, Ariz. <sup>7/55</sup>	216,000		8	38	62		1, 3, 6
365. Pittsburg, Calif. <sup>7/55</sup>	17,000		2			100	1, 4
366. Pittsburg, Kan.	21,000		6		100		1-3, 5
367. Pittsburgh, Pa.	550,000	100,000	1, 2	100			1, 3, 6, 7
368. Pomona, Calif. <sup>7/55</sup>	51,000		2		√	√	
369. Pontiac, Mich.	80,000		6		100		3, 4
370. Poplar Bluff, Mo.	17,000		3	100			1, 3
371. Portland, Me.	132,000		5	√	√		3
372. Portland, Ore. <sup>7/55</sup>	400,000	150,000	1, 2	100			3
373. Portsmouth, Va. <sup>7/55</sup>	150,000		2	80	20		1, 3, 4, 6, 7
374. Prichard, Ala.	46,000		4	75	25		1, 3
375. Providence, R.I. <sup>10/54</sup>	339,000	54,000	4	100			1, 3-7
376. Puerto Rico A.S.A. <sup>7/55*</sup>	1,300,000		5	90	10		1, 3, 4, 6, 7
377. Queens County, N.Y.*	130,000		pvt.		100		
378. Racine, Wis.	80,000		4	100			1, 3, 6, 7
379. Rahway, N.J.	23,000		1	88	12		1, 3-7
380. Reno, Nev.	55,000		pvt.	100			3
381. Richmond, Va. <sup>7/55</sup>	240,000	24,000	2	100			1, 3, 4, 6, 7
382. Ridgewood, N.J.	52,000		7		100		3
383. Roanoke, Va.	102,000	4,000	6	70	30		1, 3-7
384. Robbinsdale, Minn.	14,000		1, 2		100		3
385. Rochester, N.H.	15,000		2	100			3
386. Rochester, N.Y.*	108,000	55,000	pvt.	88	4	8	1, 3, 4, 6
387. Rome, N.Y.	44,000		6	100			3
388. Sacramento, Calif.	163,000		2	90	10		1, 3
389. St. Charles, Mo. <sup>4/55</sup>	21,000		3	100			1-3
390. St. Cloud, Minn.	30,000		1, 2	100			1, 3, 6
391. St. Louis, Mo. <sup>4/54</sup>	888,000		8	100			1-3, 6, 7
392. St. Louis County, Mo.	502,000	51,000	pvt.	100			1-4, 6
393. St. Louis Park, Minn.	38,000		1, 2		100		3
394. St. Paul, Minn.	339,000		4	100			1-3, 6, 7
395. Salem, Ohio	14,000		4	100			1-3, 6
396. Salem, Ore. <sup>7/55</sup>	42,000	4,000	6	100			3
397. Salina, Kan.	34,000		2	50	50		1-6
398. Salisbury, Md.	17,000		3		100		3, 4
399. Salt Lake City, Utah	247,000		4	87	13		2, 3, 6
400. San Angelo, Tex. <sup>10/54</sup>	65,000		1, 2	100			1, 3

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Pumping Power #			Distribution Storage¶					Distr. Pressure—psi				Distr. Temp.—°F	
	To Plant	To System	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
mil gal							days	Max.	Min.	Max.	Min.			
361	2	2, 5	2	0.4		2.0	2.4	1.6	120	100	120	40		
362	2	2	2		5.0	500.0	505.0	1.3	40	20	100	30	35	70
363	2	2	2				69.0	1.6						
364	2	2, 5	2		0.1	75.0	75.1	1.7	75	65	110	35	45	87
365	2	5	2		2.8	6.0	8.8	4.1	70	62	70	62	61	77
366	2	2	2	1.5	3.3		4.8	2.6	60	60	60	60	62	62
367	1, 2	1, 2	1, 2	13.1		446.4	459.5	4.8	100	40	200	35	36	80
368	2	2, 5	2	15.0			15.0	1.5	95	45	125	25	60	70
369	2	2	2	1.0	2.0		3.0	0.2	70	40	70	30	50	55
370	2	2	2	0.6		0.2	0.8	0.6	60	40	100	60	42	72
371		2, 5		5.9		28.0	33.9	1.8	100	59	90	34	35	64
372		5	2	1.5		175.0	176.5	2.3	90	45	90	45	40	53
373	2	2		1.5	10.0		11.5	0.8	65	45	65	30	40	82
374	2	2	2	1.7	0.5	2.3	4.5	1.6	58	50	58	50	52	76
375		2, 5	2			50.5	50.5	1.2	122	82	90	25	38	64
376	2	2, 5	2	0.4	0.2	52.5	53.1	0.7	60	25	120	25	78	80
377		2	2	0.2	4.0		4.2	0.4	50	35	50	35		
378	2	2	2	2.9			2.9	0.2	85	60	85	30	34	57
379	2	2		0.5	0.4		0.9	0.2	47	43	47	40		
380		2, 5	2			60.0	60.0	2.8	65	45	90	35	40	60
381	2	2	2	2.0	59.2		61.2	2.3	90	35	60	35	36	81
382	2	2, 5		0.2		5.5	5.7	1.6	90	70	80	60	52	58
383	5	5	2	3.7	0.7	6.0	10.4	1.0	100	90	150	20		
384		2		0.2			0.2	0.2	60	58	60	36		
385		5											34	50
386	1, 2	1, 2	2	9.9			9.9	0.5	100	30	180	30	40	70
387		5				66.0	66.0	5.8	80	60	80	60	35	70
388	2	2		9.0	14.5		23.5	0.6	50	35	50	25	43	68
389	2	2	2	0.5		2.7	3.2	2.3	90	70	70	55	30	76
390	2	2, 5	2	2.1			2.1	0.9	70	40	70	40	33	70
391	1	1	1	0.4	79.0	185.0	264.4	1.5	65	40	110	25	44	86
392	2	2, 3	2-4	1.0	20.5	2.4	23.9	0.5	140	25	140	25	45	83
393		2		2.6	1.5		4.1	1.2	62	20	62	20	65	68
394	2	1, 2		5.0		64.0	69.0	1.7	90	40	60	25	36	73
395	2	2		0.7		3.0	3.7	2.4	100	60	100	35		
396		5	2	0.5	0.2	110.4	111.1		78	70	110	40	46	63
397	2	2	2	1.8	3.0		4.8	0.9	70	26	70	26	54	70
398	2	2		1.1			1.1	0.4	48	40	48	37	60	65
399		2, 5	2						100	60	125	20	48	58
400	2	2	2	4.0			4.0	0.5	70	65	80	30	54	85

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

TABLE 1 (contd.)

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
401. San Antonio, Tex.	465,000		4		100		3
402. San Bernardino, Calif. <sup>7/55</sup>	86,000		4	5	95		3
403. San Francisco, Calif. <sup>7/55</sup>	790,000	500,000	4	99	1		3, 4
404. Sandusky, Ohio	33,000		6	100			1, 3
405. Sanford, Fla. <sup>10/55</sup>	20,000		6		100		3
406. Sanford, N.C. <sup>7/55</sup>	15,000		2	100			1, 3, 4, 6
407. Santa Barbara, Calif. <sup>7/5</sup>	65,000		9	✓	✓	✓	1, 3, 4, 6
408. Santa Cruz, Calif. <sup>7/55</sup>	28,000		6	96	4		1, 3, 6
409. Santa Fe, N.M.	33,000		pvt.	48	52		3, 4, 6
410. Santa Paula, Calif.	14,000		pvt.	32	68		3
411. Santa Rosa, Calif. <sup>7/55</sup>	37,000		3	35	65		3
412. Schenectady, N.Y.	112,000		2		100		3
413. Scottsbluff, Neb.	14,000		6		100		
414. Scranton, Pa.*	520,000		pvt.	100			1, 3
415. Seattle, Wash.	600,000	48,000	3	100			3
416. Shamokin, Pa.*	51,000	21,000	pvt.	100			3, 4
417. Sharon, Pa.*	55,000		pvt.	100			1, 3, 4, 6
418. Shawnee, Okla. <sup>7/55</sup>	30,000		6	100			1, 3
419. Sheboygan, Wis.	45,000	4,000	4	100			1, 3, 6, 7
420. Sheffield, Ala. <sup>5/55</sup>	15,000		3	100			1, 3, 7
421. Shelbyville, Ind.	13,000		pvt.		100		1, 3, 5
422. Sheridan, Wyo.	15,000		2	100			3
423. Shorewood, Wis.	17,000		2			100	
424. Shreveport, La.	180,000		7	100			1, 3
425. Sioux City, Iowa	95,000				100		3
426. Sioux Falls, S.D.	60,000		7		100		1-4
427. Snyder, Tex. <sup>10/55</sup>	17,000		6	95	5		1, 3, 4, 6
428. South Gate, Calif. <sup>7/55</sup>	40,000		2		100		
429. South Milwaukee, Wis.	15,000		2	100			1, 3, 6, 7
430. South Orange, N.J.	17,000		3		100		2, 3
431. South St. Paul, Minn. <sup>4/55</sup>	19,000		2		100		4
432. So. Calif. Water Co.*	283,000		pvt.		89	11	1, 3, 6
433. Spokane, Wash.	185,000		1		100		3
434. Springfield, Ill. <sup>2/55</sup>	110,000		2	100			1-3, 6
435. Springfield, Mass.	174,000	34,000	4	100			1
436. Springfield, Mo.	88,000		pvt.	95	5		1, 3, 5, 6
437. Stamford, Conn.	70,000	14,000	pvt.	100			3
438. Sterling, Ill.	26,000		pvt.		100		3, 4
439. Stevens Point, Wis.	16,000		4		100		3
440. Struthers, Ohio	26,000		pvt.	100			1, 3, 6

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission;

5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power #				Distribution Storage†					Distr. Pressure—psi				Distr. Temp.—°F	
	To Plant	To Sys-tem	Booster	El	G-P	G-G	Total	Bus. Dist.		Res. Dist.		Jan.	Jul.	
								Max.	Min.	Max.	Min.			
				mil gal							days			
401	2	1-3	2, 3	5.4	2.3	10.8	18.5	0.3	90	40	90	40	75	75
402	2	2, 5	2			43.6	43.6	2.3					67	70
403	2			0.2		318.0	318.2	2.3					52	65
404	2	2		2.0			2.0	0.3	75	40	75	35	34	74
405	2	2, 3		0.4	1.0		1.4	1.0	70	50	60	40	60	75
406		2, 3		0.8			0.8	0.7	80	70	80	35		
407		2, 5				60.0	60.0	10.1	150	104	225	30	57	68
408	2	2, 5	2		0.5	45.3	45.8	8.3	115	60	90	30	47	67
409		2, 5	2						75	65	120	20	36	55
410			2	1.6		5.0	6.6	3.7	90	80	120	30		
411		2	2			2.3	2.3	0.6	50	40	60	40	60	70
412		2				20.0	20.0	1.0	100	70	125	90	67	54
413		2		0.4			0.4	0.1	50	35	45	30		
414	2	1-5	2						65	50				
415		5	2	5.0		354.9	359.9	4.2	135	50	125	30	36	62
416		2, 5	2	8.7			8.7	2.2	115	110	115	20	38	55
417	2	1, 2	2	7.0		2.0	9.0	1.4	138	138	100	50	33	75
418	3	3, 5		1.0			1.0	0.5	65	58	60	58		
419	2	2		4.0			4.0	0.5	80	58	65	40	36	54
420	2	2	2	0.9			0.9	0.7	50	40	60	30	40	84
421	2	2		0.3	0.4		0.7	0.4	65	60	65	54	51	54
422		5	2	0.3		6.0	6.3	2.5	100	40	70	20	40	60
423		2							80	60				
424		2		2.0	4.0	8.0	14.0	0.7	90	60	60	40	52	85
425	2	2	2	0.3		24.0	24.3	2.4		80				
426	2	2, 3	2	2.2	5.2		7.4	0.7	75	65	65	50	50	55
427	2	2	2	0.3	2.0		2.3	1.3	100	80	90	46	68	68
428		5		3.0			3.0	0.3	57	50	57	50	68	68
429	2	2	2	0.5	1.2	1.7	3.4	1.3	70	50	70	30	35	61
430	2	2	2	0.2		3.5	3.7	2.3	120	115	130	48	54	60
431		2	2	0.3		2.0	2.3	1.4	95	50	58	20	55	65
432	2	2	2	1.3	15.6	18.3	35.2	0.7	120	35	120	35	68	68
433		2	2	5.8		77.5	83.3	2.9	85	83	120	38	48	51
434	2	1, 2	2	1.0	6.0		7.0	0.5	55	45	55	30		
435	5	5				29.0	29.0	0.9	145	120	80	60	36	54
436	2-5	1		3.0	2.0		5.0	0.7	90	53	95	30	47	79
437		2	2						90	65	100	7	42	75
438	2	2		0.2			0.2	0.1	65	55	60	50	65	65
439	2	2		1.3			1.3	0.7	72	60	72	60	45	60
440	2, 5	2		1.2			1.2	1.0	160	50	120	35	40	66

§ Key: S—surface water; G—ground water; P—purchased water; † percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
441. Superior, Wis.	35,000		pvt. 3	100		100	1, 3, 5
442. Swampscott, Mass.	12,000						
443. Syracuse, N.Y.	250,000		1		100		3
444. Tacoma, Wash.	165,000		3	95	5		3, 6
445. Tampa, Fla. <sup>10/55</sup>	235,000		1	100			1-4, 6
446. Taunton, Mass.	40,000	3,000	4	100			3
447. Terrell, Tex. <sup>4/55</sup>	13,000		2	100			1, 3, 6
448. Texarkana, Tex.	51,000		4	70	30		1, 3-6
449. Texas City, Tex. <sup>7/55</sup>	30,000		2		100		3
450. Toledo, Ohio	453,000	15,000	6, 8	100			1-4, 6, 7
451. Tonawanda, N.Y.	17,000		2	100			1, 3, 6, 7
452. Topeka, Kan.	122,000		4	90	10		1-6
453. Torrance, Calif. <sup>7/55</sup>	45,000		2		25	75	3
454. Torrington, Conn.	25,000		pvt.	100			3
455. Tucson, Ariz. <sup>3/55</sup>	94,000		6		100		3
456. Tulare, Calif. <sup>7/55</sup>	13,000		4		100		none
457. Tulsa, Okla. <sup>7/55</sup>	240,000	27,000	4	100			1, 3, 7
458. Two Rivers, Wis.	11,000		2	100			1, 3, 6, 7
459. Uniontown, Pa.	25,000		pvt.	100			1, 3, 4
460. Vancouver, Wash.	55,000		6		100		3
461. Ventura, Calif. <sup>7/55</sup>	31,000		6	70	30		2, 3, 6
462. Vernon, Tex. <sup>4/55</sup>	14,000		1, 2		100		3
463. Vincennes, Ind.	24,000		4		100		3
464. Virginia, Minn. <sup>4/55</sup>	15,000		4	10	90		1, 3
465. Walla Walla, Wash.	27,000		7	88	12		3
466. Wallingford, Conn.	23,000		4	100			1, 3, 4
467. Washington, D.C. <sup>7/55</sup>	850,000	194,000	9	100			1, 3, 4, 6, 7
468. Washington, Ind.	13,000			✓	✓		1, 3, 5, 6
469. Washington C. H., Ohio*	13,000		pvt.	55	45		1-3, 5, 6
470. Waterloo, Iowa	70,000	1,000	4		100		3
471. Watertown, N.Y. <sup>7/55</sup>	38,000		6	100			1, 3, 4, 6
472. Watertown, S.D.	14,000		1	88	12		1, 6, 7
473. Waterville, Me.	30,000		5	100			3
474. Waukegan, Ill. <sup>6/55</sup>	49,000		1, 2	100			1, 3, 6, 7
475. Wauwatosa, Wis.	37,000		3		100		3
476. Waycross, Ga.	21,000		6		100		3, 7
477. Webster, Mass.	14,000		4		100		none
478. West Allis, Wis.	62,000		3			100	
479. W. University Place, Tex.	18,000		6		100		3
480. West View, Pa.	95,000		5		100		2, 3

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Pumping Power #				Distribution Storage¶					Distr. Pressure—psi				Distr. Temp.—°F	
	To Plant	To Sys-tem	Booster	El	G-P	G-G	Total		Bus. Dist.		Res. Dist.		Jan.	Jul.
							mil gal	days	Max.	Min.	Max.	Min.		
441	2	2			1.3		1.3	0.4	59	50	59	35	40	60
442		5		0.9			0.9		92	60	92	38		
443		5	2	13.8		235.0	248.8	5.3			105	25	43	67
444		2, 5	2						104	45	130	30	39	59
445	1, 2	1, 2	2	4.7	7.5		12.2	0.5	70	50	70	40	55	80
446		1-3		0.3		22.5	22.8	4.6	72	62	80	50	40	72
447	2	2	2	0.7	0.3		1.0		60	55	45	40	40	80
448	1, 2	1, 2	2	1.5	3.0		4.5	1.3	85	75	90	50	68	80
449	2	2	2	0.4	1.4		1.8	0.7	55	50	55	50		
450	2	2		1.0	40.0		41.0	0.6	65	40	65	40	34	75
451	2	2		0.5			0.5	0.1	55	50	45	35	34	75
452	2	1, 2	2	1.5	11.0		12.5	1.0	80	50	85	30	45	85
453		2, 5	2	0.2	3.0	10.0	13.2	1.2	80	60	95	60	62	65
454		5		1.3			1.3	0.3	95	80	95	25	40	70
455		2, 5	2	2.0	10.0	20.0	32.0	2.2	70	65	70	35	65	84
456		2		0.2			0.2	0.0	55	45	55	45		72
457	5	1, 2	2	2.5		27.5	30.0	0.7	80	70	100	20	42	87
458	2	2	2	1.0	1.5		2.5	1.8	65	55	60	55	37	55
459	2	2	2			3.5	3.5	1.7			150	40	48	65
460	2	2, 5	2	1.3	2.0	13.1	16.4	2.0	82	62	110	42		
461	2	2, 5	2				38.2	6.8	90	50	125	35	65	71
462	2	2, 5	2	1.0	1.8	0.2	3.0	2.0	65	55	80	55	50	65
463		2		1.0			1.0	0.5	90	70	90	45	57	60
464	2	2	2	0.1	1.3		1.4	0.7	60	50	60	30	50	54
465	2	2, 5				15.0	15.0	1.6	130	60	150	50	35	56
466	2	2	2						110	70	100	70	35	72
467	2	2, 5	2	2.7	45.0	100.4	148.1		90	35	90	30	52	80
468	2	2	2	0.5			0.5	0.4	65	60	70	35	56	63
469	2, 5	2		0.3	0.2		0.5	0.5	57	52	55	45		
470		2, 5		3.0	7.0		10.0	1.2	80	80	80	80	47	54
471	2, 4	2, 4		8.0	0.8		8.8	1.9	74	66	100	45	37	78
472	2	2		1.2			1.2	0.9	55	50	55	50		
473		2				40.0	40.0		100	85	125	45	40	68
474	2	2	2	0.7	4.5		5.2	0.8	64	54	90	22	32	60
475	2	2	2	1.5	4.5		6.0	1.6	95	80	85	35	54	58
476	2, 3	2		0.9	0.8		1.7	1.0	60	50	60	40	76	76
477		1, 2		2.7			2.7	2.4	120	90	85	46	56	62
478		2		1.0			1.0	0.2	60	40	60	40		
479	2	2		0.5	0.4		0.9	0.4	65	45	65	45	70	70
480	2	2	2	2.8	12.5		15.3	1.9	125	65	200	65	55	60

§ Key: S—surface water; G—ground water; P—purchased water; √ percentage unreported.

¶ Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

\* Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

† El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

TABLE 1 (contd.)

1	2	3	4	5	6	7	8
Community*	Population Served		Public Control Agency†	Source of Supply —per cent‡			Type of Treatment
	Retail	Wholesale		S	G	P	
481. Westchester County, N.Y.*	42,000		5	75		25	1, 3, 4, 6
482. Westerly, R.I.	18,000		4		100		
483. Westmoreland County, Pa. <sup>4/55</sup>	146,000		5	100			1, 3-6
484. Weymouth, Mass.	42,000		4	94	6		1, 3, 4
485. Whittier, Calif. <sup>7/55</sup>	32,000		6		100		none
486. Wichita, Kan.*	237,000		pvt.*		100		1-5
487. Wilkinsburg-Penn, Pa.	210,000	†	5	100			1, 3-7
488. Williamsport, Pa. <sup>7/55</sup>	60,000		5	95	5		3
489. Wilmington, N.C. <sup>7/55</sup>	55,000		2	100			1
490. Wilson, N.C. <sup>7/55</sup>	28,000		1, 2	100			1, 3, 4, 6, 7
491. Winnetka, Ill. <sup>4/55</sup>	14,000	3,000	6	100			1, 7
492. Wisconsin Rapids, Wis.	14,000		4		100		5
493. Worcester, Mass.	208,000		6	100			3
494. Wyandotte, Mich. <sup>10/55</sup>	42,000		4	100			1, 3, 4, 6, 7
495. Yonkers, N.Y.	160,000		2, 3		46	54	1, 3
496. York, Pa.	100,000		pvt.	100			1, 3
497. Youngstown, Ohio	196,000	4,000	1			100	

\* See notes beginning on p. 694.

† Included in preceding column.

‡ Key: 1—mayor; 2—council; 3—board of public works, utilities, or services; 4—water board or commission; 5—water authority or district; 6—city manager; 7—city commission or commissioner; 8—director of public works, utilities, or services; 9—other; pvt.—private.

1	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Pumping Power #			Distribution Storage¶				Distr. Pressure—psi				Distr. Temp.—°F		
	To Plant	To System	Booster	El	G-P	G-G	Total	Bus. Dist.		Res. Dist.		Jan.	Jul.	
				mil gal				Max.	Min.	Max.	Min.			
				days										
481	2	2		1.0		0.4	1.4	0.3	110	100	125	20	35	83
482		1, 2		2.3			2.3	1.2	100	90	100	45	52	52
483	2	2, 5	2	12.0		113.0	125.0	5.9	150	50	175	35		
484	2	2, 5	2	4.1			4.1	1.5	120	30	120	30	34	78
485		2, 4	2	0.3		23.4	23.7	4.2	90	47	108	40	62	64
486	2	2, 4	2	2.3	7.8		10.1	0.3	108	85	100	35	62	72
487	2	5	2	2.4		42.3	44.7	2.7	175	35	175	15	39	78
488	2	2, 5	2	0.5		4.0	4.5	0.7	60	50	175	20	40	69
489	2	2		2.0	5.0		7.0	1.3	65	55	65	50	51	86
490	2	2		1.0	2.0		3.0	1.2	65	60	55	50	45	84
491	2	1, 2			2.2	2.2	4.4	1.6	55	35	55	30	45	65
492	2	2		0.8	0.4		1.2	0.8	75	65	75	55	48	50
493		5	2			4.0	4.0	0.2	165	100	165	20	40	75
494	2	2		0.5	4.3		4.8	0.8	55	40	55	40	40	70
495	2	2, 5	2	1.0		60.0	61.0	2.8	150	30	150	30		
496	1, 2	5	2	3.6		32.0	35.6	2.2	90	75	80	50		
497			2	7.5		32.6	40.1		101	98	100	37	33	72

§ Key: S—surface water; G—ground water; P—purchased water; ¶ percentage unreported.

|| Key: 1—filtration; 2—softening; 3—chlorination; 4—corrosion control; 5—iron or manganese removal; 6—taste and odor control; 7—fluoridation.

# Key: 1—steam; 2—electric; 3—diesel; 4—other; 5—gravity (no pumping).

¶ El—elevated; G-P—ground storage, pumped; G-G—ground storage, gravity.

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
1. Aberdeen, S.D.	7.5	48	20	68	3.0	483	7.1
2. Adrian, Mich. 7/88		33	10	43	2.2		
3. Akron, Ohio	25.3	577	181	758	2.6	9,967	13.1
4. Albany, N.Y.	23.0	217	74	291	2.2	4,369	15.0
5. Albemarle, N.C. 7/88	6.0	49	12	61	4.1	642	10.5
6. Albert Lea, Minn.	0.3	44	2	46	2.9		
7. Albion, Mich.						430	
8. Albuquerque, N.M. 7/88		532	81	613	3.6	4,615	7.5
9. Alexandria, La. 8/88	8.0	64	16	80	1.5	1,400	17.5
10. Alhambra, Calif. 7/88	4.0	116	14	130	2.4		
11. Allen Park, Mich.	6.0	90	5	95	2.7	500	5.3
12. Alliance, Ohio	3.0	70	13	83	2.7	775	9.3
13. Amarillo, Tex. 10/88	65.0	183	56	239	1.8	3,122	13.1
14. Americus, Ga.						150	
15. Ames, Iowa	0.7	50	9	59	2.6	984	16.7
16. Anaheim, Calif.	2.0			112	2.5	1,762	15.7
17. Annapolis, Md. 7/88							
18. Anniston, Ala. 4/88		50	52	102	2.1	1,285	12.6
19. Ansonia, Conn.	2.9	34	8	42	2.3		
20. Antioch, Calif. 7/88	2.5	43	12	55	3.9	500	9.1
21. Appleton, Wis.						1,781	
22. Arcadia, Calif. 7/88	15.8	103	20	123	3.5	1,536	12.5
23. Arlington, Va. 7/88	2.6	300	55	355	2.2	9,000	25.4
24. Asheville, N.C. 7/88	40.0	265	83	348			
25. Ashland, Ohio	1.0	70	15	85	5.3	600	7.1
26. Athol, Mass.	8.0	40	7	47	3.9	510	10.8
27. Atlanta, Ga.	9.0	1,021	224	1,245	2.4	14,800	11.8
28. Atlantic City, N.J.	13.2	99	33	132	1.5	1,303	9.9
29. Auburn, Me.	6.0	48	19	67	3.5	788	11.7
30. Auburn, N.Y. 7/88	2.0	70	17	87	1.8	1,565	18.4
31. Augusta, Ga.	9.0						
32. Augusta, Me.	2.0	56	14	70	3.2	939	13.4
33. Austin, Minn. 3/88							
34. Austin, Tex. 10/88		376	107	483	2.5		
35. Baltimore, Md.	26.5	1,402	735	2,137	1.6	28,867	13.5
36. Bangor, Me.	0.1	68	18	86	2.7	1,220	14.1
37. Barberton, Ohio		81	19	100	2.9	2,100	21.0
38. Batavia, N.Y.	0.0	40	5	45	2.5	335	7.5
39. Baton Rouge, La.		162	56	218	1.3	2,185	10.0
40. Bay City, Mich. 7/88	3.6	170	30	200	3.3	1,364	6.8

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
1	388	5.7	886	511	375	886	0.0	105	105	0
2	260	6.0	1,317	1,216	none	1,216	7.7	180	167	6
3	6,104	8.1	14,184	11,910	35	11,945	15.8	130	110	8
4	2,419	8.3	8,925					181		
5	298	4.9	773		none			141		
6	360	7.8	545	409	136	545	0.0	93	93	0
7	275		1,212	1,198		1,198	1.2	255	252	
8	2,131	3.5	8,538	7,750		7,750	9.2	137	125	3
9	644	8.1	1,615	1,165	220	1,385	14.2	82	69	9
10	848	6.5	2,990	2,600	4	2,604	12.9	149	129	8
11	860	9.1	940	940	none	940	0.0	74	74	0
12	623	7.5	2,098	1,522	134	1,656	21.1	185	146	14
13	1,155	4.8	7,356	6,441	none	6,441	12.4	155	136	11
14	200									
15	502	8.5	629	502	46	548	12.9	75	65	4
16	1,312	11.7	2,427	1,549	none	1,549	36.2	148	94	22
17			610	550	§			62		
18	334	3.3	2,822	2,383	none	2,383	15.6	125	105	12
19	277	6.6	883	636	*115	751	15.0	135	114	9
20	490	8.9	877		17			172		
21	1,029		1,940	1,496	109	1,605	17.3	129	107	
22	826	6.7	3,890	3,480		3,480	10.5	304	272	9
23	2,160	6.1	6,045	4,745	1,300	6,045	0.0	84	84	0
24	1,734	5.0	3,451	2,231	100	2,331	32.4	95	64	9
25	358	4.2	550					94		
26	302	6.4	360	346		346	3.9	82	79	1
27	10,232	8.2	20,544	16,852	2,573	19,425	5.4	104	99	2
28	1,432	10.9	3,676	3,260	100	3,360	8.6	112	102	7
29	314	4.7	740					107		
30	844	9.9	3,278					187		
31				4,337		4,337			79	
32	258	3.7	1,163		none			145		
33	539		1,185	895		895	24.5	135	102	
34	3,326	6.7	11,879	10,900		10,900	8.2	162	149	5
35	12,867	6.0	70,352					148		
36	524	6.1	1,365	1,365		1,365	0.0	117	117	0
37	912	9.1	1,766	1,716	50	1,766	0.0	138	138	0
38	403	9.0	715	560	25	585	18.2	109	89	8
39	2,228	10.2	5,026	4,615	none	4,615	8.2	81	74	5
40	1,189	6.0	3,427	2,921	none	2,921	14.7	147	125	7

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community <sup>a</sup>	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.‡	Total	Per Mile of Main
41. Beaver Falls, Pa.		100	33	133	2.0	2,770	20.8
42. Beckley, W. Va.	11.0	45	12	57	1.1		
43. Bellaire, Ohio	0.2	23	4	27	2.1		
44. Bellaire, Tex. <sup>10/55</sup>	0.0	29	2	31	1.4	260	8.4
45. Bellingham, Wash.	2.8	123	37	160	4.1	2,786	17.3
46. Belmont, Mass.		68	15	83	2.8	2,200	26.6
47. Bemidji, Minn.	0.1	32	3	35	3.5	182	5.2
48. Benton Harbor, Mich.	0.8	46	10	56	2.5	642	11.5
49. Berlin, N.H.	10.0						
50. Beverly Hills, Calif. <sup>7/55</sup>	6.5						
51. Bexley, Ohio <sup>11/55</sup>				40	2.9		
52. Billings, Mont.		56	26	82	1.4		
53. Binghamton, N.Y.	0.5	123	28	151	1.6	2,424	16.0
54. Birmingham, Ala.	9.0	462	165	627	1.2		
55. Birmingham, Mich. <sup>7/55</sup>		80	14	94	4.1		
56. Bismarck, N.D. <sup>7/55</sup>	8.4	49	6	55	2.4	555	10.1
57. Bloomfield, N.J.		93	10	103	2.0		
58. Bloomington, Ill. <sup>5/55</sup>	28.0	80	13	93	2.4	1,256	13.5
59. Boone, Iowa	7.0	48	14	62	4.8	562	9.1
60. Boston, Mass.	72.8	441	581	1,022	1.4	16,514	16.1
61. Boulder, Colo.	23.0						
62. Braddock, Pa.		12	1	13	0.8		
63. Bradenton, Fla.	7.0	47	6	53	3.8		
64. Bradford, Pa.	17.4	39	6	45	2.3	844	19.6
65. Brawley, Calif. <sup>7/55</sup>	0.4	35	4	39	2.8	343	8.8
66. Bremerton, Wash.	11.0						
67. Bridgeport, Conn.	37.9	591	147	738	2.8		
68. Bristol, Tenn. <sup>6/55</sup>		27	14	41	2.0	720	17.5
69. Bristol, Va.	19.2	42	7	49	2.7	801	16.3
70. Brockton, Mass.	28.0	118	17	135	2.1	2,100	15.6
71. Brookline, Mass.		84	41	125	2.2	1,616	12.9
72. Brownsville, Tex.				90	1.8		
73. Buffalo, N.Y.	1.3						
74. Burbank, Calif. <sup>7/55</sup>	0.0	185	54	239	2.6	2,806	11.7
75. Burlington, Iowa	0.8	71	25	96	3.1	1,269	13.2
76. Burlington, N.J.		28	7	35	2.5		
77. Burlington, N.C. <sup>7/55</sup>	9.0	95	9	104	3.5		
78. Butte, Mont.	90.6	131	28	159	2.8	1,895	11.9
79. Cambridge, Ohio	1.2	32	5	37	2.1	409	11.0
80. Canton, Ohio	5.0	286	69	355	2.6		

<sup>a</sup> See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcdl	Distr. gpcdl	Loss per Main-Mile 1,000 gpcdl
	Total	Per Mile of Main		Sold	Free	Total				
41	895	6.7	2,533	1,510	none	1,510	40.4	107	64	21
42	172	3.0	846	705	none	705	16.7	46	39	6
43	310	11.5	787	630		630	19.9	166	133	16
44	225	7.3	941	802	139	941	0.0	117	117	0
45	914	5.7	*3,588	3,588	none	3,588	0.0	250	250	0
46	634	7.6	727	694	§			67		
47	226	6.5								
48	457	8.2	1,052	875	§			131		
49	200		1,034					157		
50	795		3,203	3,203	none	3,203	0.0	204	204	0
51	400	10.0	375					73		
52	566	6.9	3,279	2,768	none	2,768	15.6	149	126	16
53	1,368	9.1	3,680	2,650	1,030	3,680	0.0	106	106	0
54	3,488	5.6	18,519	14,695	none	14,695	20.6	100	79	17
55	572	6.1	820	792	none	792	3.4	98	94	1
56	343	6.2	844	706	138	844	0.0	100	100	0
57	1,038	10.0	1,877	1,570	224	1,794	4.4	99	95	3
58	932	10.0	1,814	1,197		1,197	34.0	131	86	19
59	536	8.7	584	498	§			123		
60	12,143	11.9	41,500	27,823	11,825	39,648	4.5	160	153	5
61				2,060	none	2,060				
62	115	8.9	703					113		
63	492	9.3	543	379	§			106		
64	378	8.4	1,384	1,292	92	1,384	0.0	190	190	0
65	272	7.0	1,338					262		
66	510		2,553	2,163		2,163	15.3	156	132	
67	4,211	5.6	15,739	14,547	1,192	15,739	0.0	161	161	0
68	258	6.3	767	764	none	764	0.4	105	105	0
69	325	6.7	866	560		560	35.4	113	73	17
70	1,300	10.0		1,857	2	1,859			64	
71	1,406	11.2	1,968	1,684	89	1,773	9.9	93	84	4
72	410	4.6	2,116	1,820	none	1,820	14.0	116	100	9
73			49,020	49,020	none	49,020	0.0	230	230	0
74	1,357	5.7	7,234	7,044	none	7,044	2.6	216	210	2
75	1,013	10.6	1,594					136		
76	319	9.1	688	688	none	688	0.0	134	134	0
77	572	5.5	1,614					143		
78	872	5.5	4,755					232		
79	276	7.5	977		15			148		
80	1,880	5.3	7,688	6,550	§			155		

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
81. Cape Girardeau, Mo.	11.4					254	
82. Carthage, Mo. <sup>7/55</sup>		45	5	50	4.2	484	9.7
83. Cedar Falls, Iowa	3.0	†69	1	†70		750	
84. Cedar Rapids, Iowa	1.6	160	40	200	2.5	3,455	17.2
85. Chambersburg, Pa.	20.2	40	8	48	2.4	480	10.0
86. Champaign, Ill.*	8.5	112	20	132	1.7	2,463	18.7
87. Charleroi, Pa.	0.0			94	2.0		
88. Charleston, S.C.	25.4						
89. Charleston, W.Va.	5.2	280	62	342	1.8	5,642	16.5
90. Charlotte, N.C. <sup>7/55</sup>	27.0	289	85	374	2.1	4,000	10.7
91. Chicago, Ill.	63.6	3,074	1,014	4,088		42,261	10.3
92. Clarksburg, W.Va.	0.0	61	17	78	1.8		
93. Clarksdale, Miss. <sup>10/55</sup>		33	0	33	1.6	477	14.5
94. Cleburne, Tex. <sup>10/55</sup>	10.0	90	1	91	4.5	1,200	13.2
95. Cleveland, Ohio	19.0	2,194	830	3,024	2.4	35,000	11.6
96. Clinton, Iowa	0.0						
97. Cobb County, Ga.	1.0	4	36	40		98	
98. Coffeyville, Kan.	1.0	54	13	67	3.0	700	10.4
99. Collinsville, Ill.		40	7	47	2.8		
100. Colorado Spgs., Colo.	84.0	217	119	336	4.5	3,453	10.3
101. Columbia, Mo. <sup>10/55</sup>	0.1	84	16	100	2.5	575	5.8
102. Columbia, S.C. <sup>7/55</sup>		173	56	229	2.2	2,201	9.6
103. Columbia, Tenn. <sup>7/55</sup>	1.5	41	3	44	2.3	370	8.4
104. Columbus, Miss.	0.1					435	
105. Concord, N.H.	4.0	57	34	91	3.2	841	9.2
106. Corpus Christi, Tex. <sup>8/55</sup>	60.0	342	182	524	2.9		
107. Coshocton, Ohio	2.5	30	3	33	2.1	269	8.2
108. Council Bluffs, Iowa	0.5	103	26	129	2.6	1,292	10.0
109. Covington, Ky.	2.0	79	37	116		2,325	20.0
110. Crawfordsville, Ind.		24	4	28	2.0	318	11.3
111. Cudahy, Wis.	0.3	19	5	24	1.5	333	13.8
112. Cuyahoga Falls, Ohio	1.0	97	17	114	2.8	1,800	15.8
113. Dallas, Tex. <sup>10/55</sup>		1,397	382	1,779	3.0	25,000	14.1
114. Danville, Va.	1.0	82	33	115	2.3	1,176	10.2
115. Dayton, Ohio	7.0	452	75	527	1.6	14,698	27.8
116. Dearborn, Mich. <sup>7/55</sup>		226	63	289	2.2	3,261	11.3
117. Decatur, Ala. <sup>8/55</sup>	0.1	45	17	62	2.4	985	15.9
118. De Kalb, Ill. <sup>8/55</sup>	0.0	46	9	55	3.2	719	13.1
119. De Kalb County, Ga.	2.7	661	78	739	4.6	3,700	5.0
120. Denison, Tex. <sup>8/55</sup>	0.3	80	12	92	4.4		

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
81	446		605	507		507	16.2	69	58	
82	369	7.4	333	263	33	296	11.1	76	68	2
83	376		574	460		460	19.9	93	74	
84	1,533	7.6	3,602	2,816	70	2,886	19.9	123	99	10
85	300	6.3	1,285	768	100	868	32.4	176	119	24
86	912	6.9	2,429	2,059	10	2,069	14.8	87	74	8
87	362	3.8	2,185	1,897	none	1,897	13.2	130	113	9
88			5,588					105		
89	959	2.8	7,355	5,422	none	5,422	26.3	109	80	16
90	1,909	5.1	6,673	5,500		5,500	17.6	102	84	9
91	44,548	10.9	378,532					234		
92	753	9.7	1,723	1,524	3	1,527	11.4	110	97	7
93	373	11.3	754	703	38	741	1.7	99	97	1
94	400	4.4	732	612	120	732	0	100	100	0
95	40,000	13.3	114,709	91,510	3,721	95,231	17.1	215	179	17
96	752			746	9	755			74	
97			2,139	2,100	none	2,100	1.8	78	77	
98	278	4.1		910	3	913			114	
99	230	4.9	530					86		
100	1,386	4.1	8,900	4,086	853	4,939	44.5	270	150	32
101	542	5.4	962					66		
102	1,130	4.9	4,033	3,479		3,479	13.7	104	90	6
103	205	4.7	1,057	992	36	1,028	2.7	152	148	2
104	242		817	552		552	32.4	118	80	
105	733	8.1	1,437					141		
106	1,600	3.1	13,702	13,087	none	13,087	4.5	208	199	3
107	219	6.6	850	695	155	850	0.0	146	146	0
108	1,052	8.2	1,922	1,592	182	1,774	7.7	105	97	3
109	916	7.9	3,362	2,683	645	3,328	1.0	46	46	0
110	231	8.2	433	362	none	362	16.4	85	71	7
111	225	9.4	988	988		988	0.0	169	169	0
112	1,147	10.0	1,128	1,070	25	1,095	2.9	67	65	1
113	8,295	4.7	34,186	28,146	295	28,441	16.8	150	125	9
114	830	7.2	1,478	1,199		1,199	18.9	81	66	7
115	3,476	6.6	16,493	14,993	1,500	16,493	0.0	141	141	0
116	2,132	7.4	8,461	8,461	none	8,461	0.0	178	178	0
117	390	6.3	1,758	1,618	none	1,618	8.0	172	158	6
118	468	8.5	655		none			105		
119	2,200	3.0	7,850	7,560		7,560	3.7	134	129	1
120	368	4.0	963	730		730	24.2	106	80	7

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Transmission Mains—miles	Distribution Mains—miles				Valves	
		4"-8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
121. Denton, Tex. <sup>6/55</sup>	8.0	76	36	112	4.0		
122. Denver, Colo.	155.4	740	306	1,046	1.9	14,858	14.2
123. Derby, Conn.	0.4	19	8	27	2.7	300	11.1
124. Des Moines, Iowa	0.4	443	92	535	2.5	3,872	7.3
125. Des Plaines, Ill.		41	15	56	2.2	1,200	21.5
126. Detroit, Mich. <sup>7/55</sup>	18.4	4,846	1,296	6,142	3.2	30,909	5.0
127. Dodge City, Kan.							
128. Dover, N.J.	2.1	39	4	43	3.3	604	14.0
129. Dubuque, Iowa	146.2	114	33	147	2.7	1,696	11.5
130. Duluth, Minn.	0.3	222	87	309	2.9	3,360	10.9
131. Durant, Okla. <sup>7/55</sup>	5.5						
132. Durham, N.C. <sup>7/55</sup>	24.0	145	60	205	2.4	5,070	24.7
133. Dyersburg, Tenn. <sup>7/55</sup>	0.2						
134. E. Bay M.U.D., Calif. <sup>7/55*</sup>	185.0	1,850	407	2,257	2.3	30,953	13.7
135. East Detroit, Mich. <sup>7/55</sup>	4.0	79	12	91	2.3	743	8.2
136. East Jefferson, La.	0.5	241	49	290	3.4	3,230	11
137. East Lansing, Mich. <sup>7/55</sup>	0.6	23	2	25	1.9	516	20.6
138. East Orange, N.J.	15.0	90	32	122	1.5	2,350	20.1
139. Eau Claire, Wis.	1.3	97	19	116	3.2		
140. Ecorse, Mich. <sup>7/55</sup>	34.0						
141. El Centro, Calif.		47	10	57	3.6		
142. El Dorado, Kan.		9	9	18	1.1	560	31.1
143. Elizabeth, N.J.		126	50	176	1.4	2,147	12.2
144. Elizabeth City, N.C. <sup>7/55</sup>	3.0	17	4	21	1.4	450	21.4
145. Elmira, N.Y.	3.2	137	34	171	2.4		
146. Elwood, Ind.							
147. Emporia, Kan.	5.5	52	15	67	3.7	1,152	17.7
148. Endicott, N.Y.		84	11	95	1.6	1,624	17.1
149. Erie, Pa.	5.0	290	112	402	2.7	6,149	15.3
150. Escanaba, Mich. <sup>7/55</sup>	0.3	44	8	52	3.5	400	7.7
151. Eugene, Ore.	12.0	117	21	138	3.1	1,100	8.0
152. Evanston, Ill.		108	25	133	1.8	1,389	10.4
153. Fargo, N.D. <sup>7/55</sup>	0.1	87	23	110	2.4	3,246	29.5
154. Faribault, Minn.		53	4	57	3.6	822	14.4
155. Fayetteville, N.C. <sup>7/55</sup>	6.0	114	29	143	2.4	1,823	12.8
156. Fergus Falls, Minn. <sup>4/55</sup>	0.1	33	7	40	2.9	261	6.5
157. Flint, Mich. <sup>7/55</sup>	0.0	406	84	490	2.6	6,064	12.4
158. Florence, Ala. <sup>10/55</sup>	0.0	42	14	56	1.9	278	5.0
159. Fort Collins, Colo.	56.3	42	12	54	2.4	420	7.8
160. Fort Dodge, Iowa	0.5	77	5	82	2.7	1,595	19.5

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
121			1,092	787		787	28.0	107	77	8
122	5,940	5.7	32,993	32,392	none	32,392	1.8	147	145	1
123	175	6.5	630	629	1	630	0.0	173	173	0
124	4,325	8.1	9,090	7,574	1,516	9,090	0.0	113	113	0
125	700	12.5		650	50	700			77	
126	30,231	4.9	173,747	151,075	1,530	152,605	12.2	155	137	9
127	418		1,144	616	528	1,144	0.0	262	262	0
128	311	7.2	691	348	2	350	49.3	146	74	22
129	1,094	7.4	1,678	1,233	445	1,678	0.0	85	85	0
130	1,482	4.8	5,793	3,846		3,846	33.6	148	99	17
131	234		720	600	120	720	0.0	152	152	0
132	1,430	7.0	3,089	2,600	none	2,600	15.8	100	84	7
133	240		767					162		
134	10,323	4.6	46,263	41,723	none	41,723	9.8	127	115	5
135	635	7.0		862		862		59		
136	2,690	9.3	2,866	2,486	1	2,487	13.2	92	80	4
137	166	6.6	431	325	*77	402	6.7	91	85	3
138	1,046	8.6	2,529	2,225	12	2,237	11.5	83	74	6
139	1,129	9.7	3,578	3,305	273	3,578	0.0	272	272	0
140			1,261	1,117	144	1,261	0.0	165	165	0
141	328	5.8	1,775	1,287	488	1,775	0.0	304	304	0
142	265	14.7	402					69		
143	1,255	7.1	3,791	3,254	none	3,254	14.2	80	68	9
144	298	14.2	439	313	126	439	0.0	80	80	0
145	943	5.5	2,845	2,268	45	2,313	18.7	111	91	8
146			252	240		240	4.8	53	51	
147	348	5.2	642	564		564	12.1	98	86	3
148	579	6.1	3,166	3,024		3,024	4.5	142	136	4
149	2,162	5.4	13,906	13,700	200	13,900	0.1	252	252	0
150	430	8.3	538	418	35	453	15.8	98	83	4
151	750	5.4	3,944	3,454		3,454	12.4	157	137	10
152	1,136	8.5	6,524	6,070	16	6,086	6.7	148	138	9
153	1,082	9.8	1,781	1,671		1,671	6.2	109	102	3
154	251	4.4	530	353	177	530	0.0	91	91	0
155	670	4.7	1,416	1,226	45	1,271	10.2	64	58	3
156	221	5.5	567	409	20	429	24.4	111	84	9
157	3,239	6.6	16,335	14,508		14,508	11.2	236	209	10
158	426	7.6	884	597	§			83		
159	246	4.6	2,013	2,013	none	2,013	0.0	240	240	0
160	552	6.7	1,465	1,374	20	1,394	4.9	134	127	3

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"-8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
161. Fort Madison, Iowa	2.0			31	2.1	430	13.9
162. Fort Scott, Kan.						620	
163. Fort Wayne, Ind.	4.6	266	65	331	2.4	3,099	9.4
164. Fostoria, Ohio	1.0	40	2	42	2.6	480	11.4
165. Frankfort, Ky. <sup>7/55</sup>	2.0						
166. Franklin, Ind.	0.0	20	2	22	2.2	163	7.4
167. Franklin, Pa.	4.0	21	6	27	1.9		
168. Fredericksburg, Va. <sup>7/55</sup>	0.1						
169. Freeport, Ill. <sup>10/55</sup>	0.3					789	
170. Fremont, Neb.	61.5	54	7	61	3.4	700	11.5
171. Fresno, Calif. <sup>7/55</sup>		359	91	450	3.5	4,806	10.7
172. Fullerton, Calif. <sup>7/55</sup>	1.5	31	9	40	1.0	2,300	
173. Fulton, Mo. <sup>7/55</sup>				26	2.2	200	7.7
174. Gainesville, Ga.	0.3						
175. Garden City, N.Y. <sup>8/55</sup>	0.7	70	19	89	4.2	1,074	12.1
176. Gary, Ind.	3.0	215	64	279	1.5		
177. Gastonia, N.C. <sup>7/55</sup>	2.5						
178. Glen Cove, N.Y.	0.0	59	3	62	3.1	621	10.0
179. Glendale, Calif. <sup>7/55</sup>	19.0	294	54	348	3.1	4,084	11.7
180. Gloversville, N.Y.	5.0			61	2.5	1,019	16.7
181. Goldsboro, N.C.	0.2	37	8	45	1.5	350	7.8
182. Goshen, Ind.		47	2	49	3.8		
183. Grand Island, Neb. <sup>8/55</sup>	6.0	67	17	84	3.4	626	7.5
184. Grand Junction, Colo.	38.0	67	16	83	3.3	325	3.9
185. Grand Rapids, Mich. <sup>7/55</sup>	31.0	324	124	448	2.3	6,831	15.3
186. Great Bend, Kan.	0.2	31	1	32	1.5	475	14.9
187. Green Bay, Wis.		113	31	144	2.4		
188. Greensboro, N.C. <sup>7/55</sup>	13.8	189	28	217	2.4	2,288	10.6
189. Greenville, Miss. <sup>10/55</sup>	1.0	109	37	146	3.5	435	3.0
190. Greenville, N.C. <sup>7/55</sup>		120	15	135	7.5	604	4.5
191. Greenville, S.C. <sup>8/55</sup>	58.9	151	41	192		2,604	13.6
192. Greenwood, Miss. <sup>10/55</sup>	0.0	251	2	253	13.4	400	1.6
193. Greenwood, S.C.	7.9	24	8	32	1.4	325	10.0
194. Griffin, Ga. <sup>12/54</sup>	8.0						
195. Haddonfield, N.J.	0.8			38	3.2		
196. Hagerstown, Md.	20.0			143	2.9		
197. Hamilton, Ohio	5.0	95	30	125	1.8	1,451	11.6
198. Hammond, Ind.	2.0	225	123	348	3.5		
199. Hannibal, Mo. <sup>8/55</sup>	2.0	16	11	27	1.3	840	31.1
200. Hanover, Pa.	5.7	49	14	63	2.8	568	9.0

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd <sup>11</sup>	Distr. gpcd <sup>11</sup>	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
161	287	9.3	390	307		307	21.2	71	56	7
162	266		440					121		
163	1,908	5.8	7,546	7,413	62	7,475	1.0	148	146	1
164	284	6.8	584	438	146	584	0.0	100	100	0
165	300		800	680		680	15.0	110	93	
166	175	8.0	369	354	none	354	4.0	101	97	2
167			786	764	3	767	2.4	154	150	2
168	312		1,507					275		
169	518		886					76		
170	304	5.0	1,046	866	48	914	12.6	159	139	6
171	2,982	6.6	15,755	15,755	none	15,755	0.0	331	331	0
172	881		3,074	2,221	none	2,221	27.7	205	148	
173	204	7.8	254					58		
174			908					124		
175	905	10.2	1,293	1,020	22	1,042	19.4	169	136	8
176	1,517	5.4	8,514	6,292	1	6,293	26.1	127	94	22
177	698		1,695					82		
178	555	8.9	724	599	none	599	17.2	99	82	5
179	1,733	5.0	7,768	5,928	none	5,928	23.7	190	145	15
180	521	8.6	1,103	1,075	28	1,103	0.0	126	126	0
181	373	8.3	789	773	3	776	1.7	72	71	1
182	258	5.3		672	§			142		
183	471	5.6	*2,695	2,430	265	2,695	0.0	295	295	0
184	225	2.7	1,845	1,462		1,462	20.6	202	160	13
185	3,774	8.4	12,703	10,828		10,828	14.7	178	152	11
186	217	6.8	785	766		766	2.4	102	100	1
187	999	7.0	2,789	2,475	none	2,475	11.3	127	113	6
188	2,149	9.9	3,655	2,653	175	2,828	22.6	109	84	10
189	492	3.4	1,831	1,819	12	1,831	0.0	126	126	0
190	421	3.1	410	390	§			62		
191	940	4.9	5,900	5,083	40	5,123	13.2	98	85	11
192	354	1.4	1,441	724	57	781	45.8	208	113	7
193	336	10.5	704	585	1	586	16.8	84	70	10
194	334		1,105	1,054	5	1,059	4.1	121	116	
195	285	7.5	385	285	none	285	26.0	88	65	7
196	540	3.8	2,527					131		
197	1,182	9.5	2,353	1,988	84	2,072	11.9	92	81	6
198	1,433	4.1	6,911	5,944	none	5,944	14.0	150	129	8
199	360	13.3	635	595	40	635	0.0	83	83	0
200	220	3.5	678	556	20	576	15.1	81	69	4

§ Amount not known.

<sup>11</sup> Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"-8"	10" & Over	Total	Per 1,000 Pop.‡	Total	Per Mile of Main
201. Harlingen, Tex.		54	17	71	2.2	498	7.0
202. Hartford, Conn.*	29.7	519	281	800	2.4	17,912	22.5
203. Hastings, Neb.							
204. Haverstraw, N.Y.	0.0	37	5	42	3.8	394	9.4
205. Helena, Ark.		17	4	21	1.9	400	19.0
206. Hibbing, Minn.	3.5	63	11	74	3.5	548	7.4
207. Highland Park, Mich. <sup>7/55</sup>	11.6						
208. Hilo, T.H.*							
209. Holland, Mich.	1.8	48	12	60	3.2	907	15.1
210. Hollywood, Fla. <sup>10/55</sup>		18	15	33	0.7	307	9.3
211. Honolulu, T.H.	31.6	287	155	442	1.7	9,300	21.0
212. Hopkinsville, Ky. <sup>8/55</sup>	1.0			81	4.1	600	7.4
213. Hoquiam, Wash.	12.0	18	6	24	1.8	660	27.5
214. Hot Springs, Ark.	3.0	34	10	44	1.3	4,340	9.9
215. Houston, Tex.	5.8	745	253	998	1.4		
216. Huntington Pk., Calif. <sup>7/55</sup>	1.0	42	11	53	1.8	773	14.6
217. Hutchinson, Kan. <sup>2/55</sup>						587	
218. Independence, Kan.	0.1						
219. Independence, Mo.		150	31	181	2.6	2,515	13.9
220. Indianapolis, Ind.	4.5	751	308	1,059	2.0	8,505	8.0
221. Ironton, Ohio <sup>2/55</sup>	1.0	37	11	48	3.0	350	7.3
222. Ithaca, N.Y.	1.5	56	7	63	1.9	1,200	19.1
223. Jackson, Mich. <sup>7/55</sup>	0.3	133	32	165	3.0	1,900	11.5
224. Jacksonville, Fla.		234	106	340	1.1	3,335	9.8
225. Jacksonville, Ill.							
226. Jamaica, N.Y.	0.0	664	114	778	1.4	12,328	15.9
227. Jamestown, N.Y.						1,867	
228. Janesville, Wis.		84	11	95	3.2		
229. Jefferson City, Mo.	0.1	49	4	53	1.9	425	8.0
230. Jeffersonville, Ind.		48	6	54	2.1	737	13.6
231. Johnson City, N.Y. <sup>6/55</sup>		38	6	44	1.7	1,063	26.5
232. Johnstown, N.Y.		34	12	46	4.2	500	10.9
233. Jonesboro, Ark.	0.9	50	3	53	2.9	903	17.0
234. Junction City, Kan.	0.1	21	5	26	1.6	485	18.6
235. Kalamazoo, Mich.		222	38	260	3.1	2,927	11.2
236. Kankakee, Ill.	0.1	57	22	79	1.6	800	10.1
237. Kansas City, Mo. <sup>8/55</sup>	0.6	708	235	943	1.3	18,500	19.6
238. Kearney, Neb.		35	3	38	2.9	298	7.9
239. Kennewick, Wash.		64	14	78	3.9	487	6.3
240. Kenosha, Wis.	0.7	124	28	152	2.5	2,061	13.5

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
201	370	5.2	1,790	1,790	none	1,790	0.0	149	149	0
202	5,154	6.5	14,952	13,278		13,278	11.2	121	107	6
203			1,743	1,635		1,635	6.2	191	179	
204	245	5.8	412	302	none	302	26.7	103	75	7
205	185	8.8	395					98		
206	295	4.0	1,059	700	none	700	33.9	138	91	14
207			4,521					269		
208	622			1,244		1,244			103	
209	553	9.2	976	896		896	8.2	141	129	4
210	462	14.0	1,470	1,262		1,262	14.1	81	69	17
211	3,753	8.5	13,516	12,112	none	12,112	10.4	143	128	9
212	286	3.5	567	474	none	474	16.4	78	65	3
213	198	8.3	580	468	§			122		
214	313	7.1	1,065	839	25	864	18.9	89	72	13
215			29,565	21,433	2,070	23,503	20.5	112	89	16
216	492	9.3	1,564	1,251	313	1,564	0.0	143	143	0
217	967		2,369					171		
218	235		513	513		513	0.0	94	94	0
219	1,043	5.8	1,861	1,545	65	1,610	13.5	73	63	4
220	9,506	9.0	23,027	20,221	none	20,221	12.2	122	107	8
221	265	5.5	500		none			76		
222	541	8.6	1,168	850	318	1,168	0.0	94	94	0
223	1,450	8.8	4,600	4,500	100	4,600	0.0	230	230	0
224	2,275	6.7	12,137					111		
225			816	648		648	20.6	90	71	
226	9,447	12.1	17,457	15,316	§			87		
227	1,031		1,838	1,502	none	1,502	18.3	101	82	
228	791	8.3	2,063	1,483	580	2,063	0.0	188	188	0
229	399	7.5	522	489	none	489	6.3	51	48	2
230	351	6.5	928	774	none	774	16.6	98	82	8
231	352	8.0	2,327					245		
232	300	6.5	991					246		
233	358	6.8	622	590	2	592	4.8	85	81	2
234	224	8.6	663	431	232	663	0.0	113	113	0
235	1,523	5.9	3,798	3,617	none	3,617	4.8	125	119	2
236	526	6.7	3,309	3,148		3,148	4.9	185	176	6
237	11,560	12.3	33,842	26,241	202	26,443	21.8	130	102	21
238	269	7.1	770	694	none	694	9.9	162	146	5
239	171	2.2	1,635	992	2	994	39.2	224	136	22
240	1,249	8.2	3,415	2,979	125	3,104	9.1	156	142	6

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
241. Kent, Ohio	0.5	28	3	31	2.6	500	11.3
242. Keokuk, Iowa	0.5	40	4	44	2.7		
243. Key West, Fla. <sup>9/55*</sup>	129.0	33	2	35	0.9		
244. Kirksville, Mo.	2.5						
245. Klamath Falls, Ore.	0.0	69	10	79	3.4		
246. Knoxville, Tenn.	14.0	323	64	387	2.3	11,067	28.6
247. Laconia, N.H.	2.5	21	8	29	2.1	323	11.1
248. La Crosse, Wis.	3.2	98	18	116	2.4		
249. Lafayette, La. <sup>10/55</sup>	0.2	98	18	116	3.1	1,020	8.8
250. Lake Worth, Fla. <sup>11/55</sup>							
251. Lakeland, Fla. <sup>9/55</sup>		84	8	92	1.9	2,095	22.8
252. Lakewood, Ohio	6.0	92	18	110	1.6	1,113	10.1
253. La Mesa, Calif.*		249	74	323	4.8		
254. Lancaster, Ohio	0.0			68	2.3		
255. Laredo, Tex.	0.2	55	16	71	1.1		
256. Las Cruces, N.M. <sup>7/55</sup>		44	4	48	2.4	630	13.1
257. Las Vegas, Nev. <sup>7/55</sup>	20.0	135	32	167	3.6		
258. Latrobe, Pa. <sup>4/55</sup>	6.0	48	13	61	3.0	529	8.8
259. Lawrence, Kan.	0.3	58	13	71	2.8	650	9.2
260. Leavenworth, Kan.	0.4	33	11	44	1.8	415	9.4
261. Lebanon, Pa.	35.0	59	12	71	1.3	1,743	24.6
262. Lewiston, Idaho <sup>7/55</sup>	1.2	46	7	53	41		
263. Lewistown, Pa.	27.0	32	13	45	1.8	525	11.7
264. Lima, Ohio	5.0	120	29	149	2.1	3,048	20.4
265. Lincoln, Neb. <sup>9/54</sup>	45.0	257	48	305	2.4	2,896	9.5
266. Lincoln Park, Mich. <sup>7/55</sup>	4.0	121	7	128	2.7	540	4.2
267. Little Rock, Ark.	36.0	191	71	262	1.9	3,388	12.9
268. Logansport, Ind.	0.2					900	
269. Long Beach, Calif. <sup>7/55</sup>	19.2	476	161	637	2.2	10,034	15.7
270. Long Island, N.Y.*		437	54	491	2.4	8,414	17.1
271. Longview, Wash.	3.0	73	11	84	2.8		
272. Lorain, Ohio	0.6	100	38	138	2.2	500	3.6
273. Los Angeles, Calif. <sup>7/55</sup>	338.0	4,677	1,018	5,695	2.5	79,061	13.9
274. Louisville, Ky.	2.0	776	198	974	2.0	12,878	13.2
275. Lynchburg, Va. <sup>7/55</sup>	20.5	95	30	125	2.2	1,461	11.7
276. Madison, Wis.	1.2	242	46	288	2.5	4,494	15.6
277. Manchester, Conn.	4.5	73	12	85	3.5	814	9.6
278. Manchester, N.H.		182	66	248	2.9	3,450	13.9
279. Manhattan, Kan.	1.4	45	7	52	2.5	685	13.2
280. Manhattan Beach, Calif. <sup>7/55</sup>	3.5	58	10	68	2.1	1,234	18.2

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpd <sup>  </sup>	Distr. gpd <sup>  </sup>	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
241			492	380	112	492	0.0	112	112	0
242	317	7.2	925	786	1	787	14.9	158	135	9
243	152	4.3		850	none	850			58	
244			292	292	none	292	0.0	67	67	0
245	396	5.0	1,783	1,526	none	1,526	14.4	212	181	8
246	2,915	7.5	7,208	7,026	none	7,026	2.5	116	113	1
247	198	6.8	351	320		320	8.8	69	63	3
248	992	8.6	3,146	2,657		2,657	15.6	180	152	12
249	739	6.4	1,564	950		950	39.2	113	69	14
250	292		1,341	1,272	§			160	151	
251	781	8.5	2,394	2,139	255	2,394	0.0	136	136	0
252	1,435	13.0	2,896	2,245	48	2,293	20.8	113	90	14
253			4,965	4,679	none	4,679	5.7	200	189	2
254	551	8.1	987					94		
255			2,435					104		
256	276	5.8	1,529	824	705	1,529	0.0	210	210	0
257	800	4.8	6,211					362		
258	186	3.1	1,590	1,578		1,578	0.8	218	216	1
259	536	7.6	1,116	980	none	980	12.2	122	107	5
260	282	6.4	787	566	221	787	0.0	90	90	0
261	640	9.0	2,614	2,364	250	2,614	0.0	130	130	0
262	252	4.8	999	962	37	999	0.0	210	210	0
263	242	5.4		816	none	816			90	
264	880	5.9	3,088					117		
265	2,357	7.7	7,416	6,135		6,135	17.3	161	133	12
266	1,250	9.8	1,495	1,113		1,113	25.5	85	64	8
267	1,697	6.5	6,352	5,660	none	5,660	10.9	87	77	8
268	324		1,080	630	none	630	41.6	118	69	
269	4,640	7.3	13,404	12,242	459	12,701	5.2	128	121	3
270	3,457	7.0	5,933	5,138		5,138	13.4	78	68	4
271	450	5.4	930	731	1	732	21.3	85	67	6
272	1,085	7.9	3,200	2,256	644	2,900	9.4	131	119	6
273	33,945	6.0	144,000	131,300		131,300	8.8	177	161	6
274	5,189	5.3	27,068	23,467	§			135		
275	884	7.1	2,293	1,694	none	1,694	26.1	110	81	13
276	2,402	8.3	5,359	4,795	*564	5,359	0.0	119	119	0
277	539	6.3	635	542		542	14.6	73	62	3
278	1,709	6.8	4,075	3,644	156	3,800	6.8	128	120	3
279	375	7.2	1,046	817	229	1,046	0.0	136	136	0
280	357	5.3	1,299	1,168	31	1,199	7.7	108	100	4

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
281. Manitowoc, Wis.	0.0	74	17	91	3.0		
282. Marinette, Wis.	1.0						
283. Marshalltown, Iowa	0.5	74	7	81	3.9	928	11.4
284. Mason City, Iowa	0.0	82	9	91	2.8	1,138	12.5
285. Massillon, Ohio	0.8	90	13	103	2.7	1,241	12.0
286. McKinney, Tex. <sup>2/66</sup>	1.2	15	3	18	1.2	76	4.2
287. Meadville, Pa.	3.2	40	4	44	2.2		
288. Medford, Ore. <sup>7/66</sup>	61.0	58	24	82	3.7	902	11.0
289. Memphis, Tenn.	17.1	809	306	1,115	2.2	10,442	9.4
290. Menasha, Wis.	0.6	35	5	40	2.7		
291. Meriden, Conn.	20.0	117	10	127	3.0		
292. Merrick, N.Y.*	0.0	232	24	256	1.7	3,545	13.9
293. Mesa, Ariz. <sup>7/66</sup>	2.0	50	7	57	2.0		
294. M.W.D. So. Calif. <sup>7/66*</sup>	242.0		350	350			
295. Miami, Fla. <sup>7/66</sup>	38.3	429	95	524	1.7	8,365	16.0
296. Michigan City, Ind.	0.5	71	15	86	2.8	1,048	12.2
297. Middletown, Conn.	5.0	44	13	57	2.3		
298. Midland, Mich. <sup>7/66</sup>	65.0						
299. Milford, Mass.	2.0	30	9	39	2.6	667	17.1
300. Milwaukee, Wis.	1.5	968	329	1,297	1.9	17,253	13.3
301. Minneapolis, Minn.	0.1	687	258	945	1.8	11,305	12.0
302. Mishawaka, Ind.	1.2	63	19	82	2.5	909	11.1
303. Missoula, Mont.	3.5	70	13	83	2.8	750	9.0
304. Mobile, Ala.	9.0					3,251	
305. Modesto, Calif. <sup>7/66</sup>				110	3.7	1,200	10.9
306. Monroe, Mich. <sup>7/66</sup>	8.0	56	15	71	2.8		
307. Monroe, N.C. <sup>7/66</sup>	2.3	30	6	36	3.0		
308. Monterey Park, Calif. <sup>7/66</sup>	9.5	31	18	49	1.6	880	18.0
309. Moorhead, Minn.	5.0	47	13	60	3.0	464	7.7
310. Mount Vernon, N.Y.	2.6	66	36	102	1.4	2,560	25.0
311. Murfreesboro, Tenn.	6.0						
312. Nacogdoches, Tex. <sup>6/66</sup>	0.5	46	5	51	3.4		
313. Nashua, N.H.		76	18	94	2.7	1,227	13.1
314. Nashville, Tenn.	8.0	558	117	675	2.9	6,132	9.1
315. Natick, Mass.	1.3	86	22	108	4.0	1,494	13.9
316. Naugatuck, Conn.	5.0	51	12	63	3.3		
317. Neenah, Wis.		44	7	51	3.4	616	12.1
318. New Albany, Ind.		74	7	81	2.0	1,176	14.5
319. New Bedford, Mass.	16.0	159	69	228	1.8	2,500	11.0
320. New Haven, Conn.		537	198	735	2.4		

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd <sup>  </sup>	Distr. gpcd <sup>  </sup>	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
281	575	6.3	1,725	1,532	none	1,532	11.2	158	140	6
282	348		893	833	60	893	0.0	175	175	0
283	487	6.0	819	618	31	649	20.8	107	85	6
284	476	5.2	1,379	898	6	904	34.5	118	77	15
285	818	7.9	979	732	64	796	18.7	71	58	5
286	204	11.3	517	500	17	517	0.0	89	89	0
287	323	7.4	839	617		617	26.5	115	85	13
288	536	6.6	2,960							
289	6,611	5.9	20,255	14,270	750	15,020	25.8	111	82	13
290	255	6.4	1,224	1,067	none	1,067	12.8	224	195	11
291	706	5.6	2,151	2,043		2,043	5.0	140	133	2
292	1,658	6.5	2,885	2,621	none	2,621	9.1	51	46	3
293	410	7.2	1,528	1,310		1,310	14.3	144	124	10
294										
295	2,709	5.2	27,025	24,933	none	24,933	7.8	148	136	11
296	618	7.2	2,687	2,419		2,419	10.0	210	189	8
297	398	7.0	775	656	119	775	0.0	85	85	0
298			*1,608	1,415	none	1,415	12.0	183	161	
299	224	5.8	345	276	§			59		
300	12,360	9.5	51,956	45,900	none	45,900	11.7	178	157	12
301	7,811	8.3	21,521	16,822	200	17,022	20.9	105	83	13
302	487	5.9	1,765	1,486	42	1,528	13.4	147	127	8
303	350	4.2	4,351	4,351	none	4,351	0.0	397	397	0
304	2,472		5,207	4,426	none	4,426	15.0	89	76	
305	732	6.7	3,064					280		
306	660	9.3	929	794	35	829	10.8	102	91	4
307	327	9.1	426	415		415	2.6	78	76	1
308	515	10.5	1,410	1,295	47	1,342	4.8	129	123	4
309	414	6.9	694	609	85	694	0.0	95	95	0
310	1,090	10.7	2,434	2,183	22	2,205	9.4	89	81	6
311	281		447	406	none	406	9.2	72	66	
312	350	6.9	527	457	none	457	13.3	96	84	4
313	684	7.3	1,365		none			107		
314	2,927	4.3	11,667	9,480	6	9,486	18.7	105	85	8
315	575	5.3	1,020	1,020	none	1,020	0.0	104	104	0
316	340	5.4	1,823	1,479	none	1,479	18.9	263	213	15
317	371	7.3	661	529	none	529	20.0	121	97	7
318	346	4.3	1,042	906		906	13.0	71	62	5
319	2,025	8.9	7,417	6,293	none	6,293	15.2	164	139	14
320	3,789	5.2	16,164		none			147		

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
321. New Iberia, La.*		45	11	56	0.9		
322. New Orleans, La.	1.8	848	227	1,075	1.7	9,300	8.7
323. New Rochelle, N.Y.	20.2	286	69	355	2.5		
324. New York, N.Y.	375.0	3,098	2,281	5,379	0.7	80,870	15.0
325. Newport Beach, Calif. <sup>7/55</sup>	3.5	55	18	73	3.7	1,431	19.6
326. Newport News, Va.*	31.0	204	119	323	1.6	7,709	23.9
327. Newton, Iowa	10.0	54	3	57	4.1		
328. Newton, Kan.	14.0	49	7	56	4.3	655	11.7
329. Niagara Falls, N.Y.	1.0	169	75	244	2.0	4,462	18.3
330. Niles, Ohio	5.0						
331. Norfolk, Neb.	0.1	28	4	32	2.5	500	15.6
332. Norfolk, Va.	113.0	432	188	620	1.7	6,462	10.4
333. North Miami, Fla.	1.0	43	5	48	1.1	238	5.0
334. North Platte, Neb.		46	6	52	3.3	500	9.6
335. Norwich, Conn.	15.0	58	23	81	2.2		
336. Oak Park, Ill.		92	17	109	1.7	1,007	9.2
337. Oak Ridge, Tenn.	4.9	100	43	143	4.5		
338. Ocala, Fla. <sup>10/55</sup>		48	7	55	3.9	400	7.3
339. Oceanside, Calif. <sup>7/54</sup>							
340. Oklahoma City, Okla. <sup>7/55</sup>	16.0	660	150	810	2.7	6,620	8.2
341. Olean, N.Y. <sup>6/55</sup>	0.0	60	8	68	3.0	1,080	15.9
342. Omaha, Neb.		632	165	797	2.7	7,638	9.6
343. Oneonta, N.Y.	2.0	40	9	49	2.5	849	17.3
344. Ontario, Calif.						2,194	
345. Orange, Calif. <sup>7/55</sup>	0.9			†66		750	
346. Orlando, Fla.	0.0	177	48	225	2.1		
347. Oskaloosa, Iowa	7.4	38	4	42	3.5	440	10.5
348. Ossining, N.Y.	2.0	33	8	41	2.6	600	14.6
349. Ottawa, Kan.	0.6					357	
350. Ottumwa, Iowa		77	23	100	2.9	856	8.6
351. Owatonna, Minn. <sup>8/55</sup>	0.0	39	3	42	3.5	752	17.9
352. Oxnard, Calif. <sup>5/55</sup>	0.0	57	10	67	2.3		
353. Painesville, Ohio	0.0	45	17	62	3.9	510	8.2
354. Palo Alto, Calif. <sup>7/55</sup>		135	14	148	3.0	3,500	23.6
355. Paris, Tex. <sup>7/55</sup>	3.0	50	10	60	2.5		
356. Pasadena, Calif. <sup>7/55</sup>	11.8	173	87	260	2.0	4,926	19.0
357. Pasco, Wash.	1.0	36	15	51	3.6	463	9.1
358. Passaic Valley Com., N.J.*	30.0	308	60	368	1.3		
359. Peekskill, N.Y.	1.5	39	14	53	2.4	1,060	20.0
360. Pendleton, Ore. <sup>7/55</sup>	23.0	27	11	38	2.7	780	20.6

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcdl	Distr. gpcdl	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
321	631	11.3	1,696	1,684	12	1,696	0.0	77	77	0
322	10,420	9.7	40,592	21,984	14,945	36,929	9.0	177	161	9
323	2,657	7.5	6,087	4,845		4,845	20.4	120	95	10
324	89,466	16.6		327,000	78,000	405,000			145	
325	626	8.6	1,288	1,006	§			176		
326	1,418	4.4	4,969	4,811	50	4,861	2.2	68	67	1
327	350	6.1	700	590	7	597	14.7	137	117	5
328	361	6.4	753	547	206	753	0.0	147	147	0
329	1,925	7.9	16,629	13,303		13,303	20.0	380	304	38
330	501		2,195	1,869	8	1,877	14.5	286	245	
331	390	12.2	684					144		
332	2,665	4.3	14,521	11,381		11,381	21.6	111	87	14
333	219	4.6	1,533	1,323	§			98		
334	336	6.5	1,228	992	116	1,108	9.8	210	190	6
335	626	7.7		1,162	44	1,206			90	
336	1,126	10.3	2,400	1,980		1,980	17.5	103	85	11
337	1,551	10.9		1,094		1,094			94	
338	371	6.7	736	623	none	623	15.4	144	122	6
339			1,335					159		
340	3,805	4.7	10,274	9,658	280	9,938	3.3	94	91	1
341	587	8.6	1,183	800	82	882	25.4	141	105	12
342	6,197	7.8	22,557	18,799	400	19,199	14.9	213	181	12
343	280	5.7	860	774	86	860	0.0	118	118	0
344	1,593		2,891		424			198		
345	467		1,019					140		
346	904	4.0	4,793	3,975		3,975	17.1	125	104	10
347	220	5.2	385	306	8	314	18.5	88	72	5
348	439	10.7	452	363	5	368	18.6	77	62	6
349	278		435	381		381	12.4	108	95	
350	866	8.7	1,384	1,244		1,244	10.1	108	97	4
351	278	6.6	653	505		505	22.6	149	115	10
352	602	9.0	1,619					153		
353	482	7.8	1,166	1,162	1	1,163	0.2	80	80	0
354	1,105	7.5	2,810	2,655	none	2,655	5.5	157	148	3
355	400	6.7	904	682		682	24.6	103	78	10
356	2,334	9.0	9,374	8,820	§			193		
357	203	4.0	1,401	1,336	65	1,401	0.0	275	275	0
358	3,299	9.0	26,095	24,136	none	24,136	7.5	179	165	15
359	500	9.4	1,776	1,250	§			221		
360	218	5.7	1,351	1,346	5	1,351	0.0	265	265	0

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
361. Phenix City, Ala.							
362. Philadelphia, Pa.	3.5	2,092	758	2,850	1.3	58,000	20.4
363. Phila. Sub. Wtr. Co., Pa.*		1,457				17,163	
364. Phoenix, Ariz. <sup>7/55</sup>	24.0	484	88	572	2.6	7,653	13.4
365. Pittsburg, Calif. <sup>7/55</sup>		18	28	46	2.7	24	
366. Pittsburg, Kan.	0.0	88	17	105	5.0	1,264	12.0
367. Pittsburgh, Pa.	18.0	661	235	896	1.6	20,000	22.3
368. Pomona, Calif. <sup>7/55</sup>	28.5			211	4.1	2,500	11.9
369. Pontiac, Mich.	0.5	172	33	205	2.6		
370. Poplar Bluff, Mo.						500	
371. Portland, Me.	41.4	260	104	364	2.8	4,979	13.7
372. Portland, Ore. <sup>7/55</sup>	75.0	748	260	1,008	2.5		
373. Portsmouth, Va. <sup>7/55</sup>	6.0	207	47	254	1.7	4,189	16.5
374. Prichard, Ala.	3.5	9	5	14		82	5.9
375. Providence, R.I. <sup>10/54</sup>	1.1	574	151	725	2.1	10,204	14.1
376. Puerto Rico A.S.A. <sup>7/55*</sup>	18.0	848	167	1,015	0.8	5,365	5.3
377. Queens County, N.Y.*	0.0	102	15	117	0.9	1,720	14.7
378. Racine, Wis.	1.4	162	41	203	2.5	3,613	17.9
379. Rahway, N.J.	4.0	45	13	58	2.5	1,100	19.0
380. Reno, Nev.	14.0	157	31	188	3.4	2,977	15.8
381. Richmond, Va. <sup>7/55</sup>	0.0	426	131	557	2.3		
382. Ridgewood, N.J.	2.0	170	14	184	3.5	1,984	10.8
383. Roanoke, Va.	13.0	205	75	280	2.7	3,008	10.7
384. Robbinsdale, Minn.						400	
385. Rochester, N.H.							
386. Rochester, N.Y.*	0.0	137	43	180	1.7	1,574	8.8
387. Rome, N.Y.	6.9	93	28	121	2.7	1,417	11.7
388. Sacramento, Calif.	0.4	363	68	431	2.6	4,742	11.0
389. St. Charles, Mo. <sup>4/55</sup>	5.0						
390. St. Cloud, Minn.		58	6	64	2.1	1,500	23.4
391. St. Louis, Mo. <sup>4/54</sup>	33.3	827	464	1,291	1.5	15,004	11.6
392. St. Louis County, Mo.	1.8	1,270	246	1,516	3.0	18,200	12.0
393. St. Louis Park, Minn.		81	24	105	2.8	1,150	10.9
394. St. Paul, Minn.	25.0	525	198	723	2.1	7,553	10.5
395. Salem, Ohio	46.0	32	7	39	2.8	129	3.3
396. Salem, Ore. <sup>7/55</sup>	17.0	87	34	121	2.9		
397. Salina, Kan.	3.0	81	18	99	2.9	984	9.9
398. Salisbury, Md.	1.4	54	11	65	3.8	693	10.7
399. Salt Lake City, Utah	79.6	454	58	512	2.1	6,090	11.9
400. San Angelo, Tex. <sup>10/54</sup>	0.0	92	27	119	1.8		

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
361			546					62		
362	23,399	8.2	142,000	135,000	5,000	140,000	1.4	177	175	2
363	4,811		15,800	12,700	none	12,700	19.6	78	63	
364	2,747	4.8	15,772	15,772		15,772	0.0	200	200	0
365	276	6.0	781	764	17	781	0.0	126	126	0
366	385	3.7	675	535	none	535	20.8	88	70	4
367	7,662	8.6	34,735	23,790	1,495	25,285	27.2	146	107	29
368	1,551	7.4	3,622	3,622		3,622	0.0	195	195	0
369	1,792	8.7	4,483	3,353		3,353	25.2	154	115	15
370	275		515	437	29	466	9.5	83	75	3
371	2,082	5.7	6,876					143		
372			28,000	23,000		23,000	17.9	140	115	14
373	1,707	6.7	4,978	3,975	none	3,975	20.2	91	73	11
374	170	12.1	1,010	945	none	945	6.4	60	56	
375	4,206	5.8	14,933	13,619	none	13,619	8.8	104	95	5
376	4,454	4.0	27,570	17,245	none	17,245	37.5	58	36	28
377	1,541	13.2	3,607	3,067	none	3,067	15.0	76	65	12
378	1,610	7.9	5,070	4,485	none	4,485	11.5	174	154	8
379	507	8.7	1,772	1,663	83	1,746	1.5	211	208	1
380	647	3.4	7,864	7,864	none	7,864	0.0	392	392	0
381	3,250	5.8	9,672	9,096	8	9,104	5.9	100	94	3
382	1,057	5.7	1,343	1,135	none	1,135	15.5	71	60	3
383	1,700	6.1	3,530	3,179	none	3,179	10.0	91	82	3
384	216		450	440	10	450	0.0	88	88	0
385			404	363		363	10.0	74	67	
386	1,036	5.8	6,707	5,559	none	5,559	17.1	113	93	18
387	727	6.0	4,176					260		
388	2,681	6.2	14,247	14,247	none	14,247	0.0	239	239	0
389			510					67		
390	631	9.9	863	550	200	750	13.1	79	69	5
391	15,248	11.8	65,644	65,469	175	65,644	0.0	203	203	0
392	7,329	4.8	16,506	14,648	none	14,648	11.2	82	73	3
393	935	8.9	1,287	1,117	170	1,287	0.0	93	93	0
394	5,871	8.1	14,268	11,880	none	11,880	16.8	115	96	9
395	379	9.7	572	473	99	572	0.0	112	112	0
396	576	4.8	3,664	2,621	34	2,655	27.6	218	158	23
397	714	7.2	1,915	1,398	517	1,915	0.0	154	154	0
398	472	7.3	1,054					170		
399	4,019	7.9	35,386	20,547	211	20,758	41.4	392	230	77
400	464	3.9	3,163	2,488		2,488	21.4	134	105	16

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Transmission Mains miles	Distribution Mains—miles				Valves	
		4"–8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
401. San Antonio, Tex.		699	152	851	1.8	6,449	7.6
402. San Bernardino, Calif. <sup>7/55</sup>		217	81	298	3.5	4,044	13.5
403. San Francisco, Calif. <sup>7/55</sup>	388.0	†850	243	†1,093		11,229	
404. Sandusky, Ohio	1.5	76	17	93	2.8	1,230	13.2
405. Sanford, Fla. <sup>10/55</sup>	0.8						
406. Sanford, N.C. <sup>7/55</sup>	0.0	31	3	34	2.3		
407. Santa Barbara, Calif. <sup>7/55</sup>	8.0	145	173	318	4.9	3,900	12.3
408. Santa Cruz, Calif. <sup>7/55</sup>	21.5	109	23	132	4.7		
409. Santa Fe, N.M.	1.0	70	16	86	2.6		
410. Santa Paula, Calif.	3.0	30	10	40	2.9	773	19.3
411. Santa Rosa, Calif. <sup>7/55</sup>	2.8	91	14	105	2.8	1,264	12.0
412. Schenectady, N.Y.		148	42	190	1.7	3,129	16.5
413. Scottsbluff, Neb.		32	2	34	2.4	662	19.5
414. Scranton, Pa.*	*			*1,292			
415. Seattle, Wash.	95.7	897	282	1,179	2.0	11,855	10.1
416. Shamokin, Pa.*	28.0	79	29	108	2.1	1,327	12.3
417. Sharon, Pa.*		97	16	113	2.1		
418. Shawnee, Okla. <sup>7/55</sup>	9.0	72	11	83	2.8		
419. Sheboygan, Wis.	1.0	94	29	123	2.7	1,405	11.4
420. Sheffield, Ala. <sup>5/55</sup>	0.3	23	3	26	1.7	585	22.5
421. Shelbyville, Ind.		23	2	25	1.9	251	10.0
422. Sheridan, Wyo.	43.0	44	10	54	3.6	450	8.3
423. Shorewood, Wis.		29	3	32	1.9		
424. Shreveport, La.		200	76	276	1.5		
425. Sioux City, Iowa	2.0	212	52	264	2.8	4,613	17.5
426. Sioux Falls, S.D.		129	34	163	2.7	2,000	12.3
427. Snyder, Tex. <sup>12/55</sup>	20.0	30	3	33	1.9	145	4.4
428. South Gate, Calif. <sup>7/55</sup>		85	20	105	2.6		
429. South Milwaukee, Wis.	5.4	42	1	43	2.9		
430. South Orange, N.J.	1.0	39	11	50	2.9	775	15.5
431. South St. Paul, Minn. <sup>4/55</sup>	2.4	41	4	45	2.4	270	6.0
432. So. Calif. Water Co.*		793	71	864	3.1	9,000	10.4
433. Spokane, Wash.	86.0	427	79	508	2.7	7,500	14.8
434. Springfield, Ill. <sup>3/55</sup>		197	56	253	2.3		
435. Springfield, Mass.	29.9	319	110	429	2.4	13,208	32.2
436. Springfield, Mo.	13.3	171	30	201	2.3	2,978	14.8
437. Stamford, Conn.	5.0	149	48	197	2.8	2,186	11.1
438. Sterling, Ill.	0.9	45	7	52	2.0	808	15.5
439. Stevens Point, Wis.	2.0	39	9	48	3.0	582	12.1
440. Struthers, Ohio	1.3	55	8	63	2.4	550	8.7

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcd	Distr. gpcd	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
401	4,672	5.5	25,627	20,813	308	21,121	17.6	151	124	15
402	2,308	7.8	6,780	6,232	150	6,382	5.9	216	203	4
403	7,237		50,909	44,042		44,042	13.5	108	94	
404	597	6.4	2,432	1,985	62	2,047	15.8	202	170	11
405	284		553					76		
406			400					73		
407	1,303	4.1	2,158	1,597	561	2,158	0.0	91	91	0
408			2,098	1,805	293	2,098	0.0	205	205	0
409	209	2.4	1,163	1,098	none	1,098	5.6	97	91	2
410	230	5.8	647		none			127		
411	474	4.5	1,419	1,274	145	1,419	0.0	105	105	0
412	2,370	12.5	7,361					180		
413	304	9.0	1,343	607		607	54.8	264	119	60
414	4,243		32,520	20,503		20,503	37.0	171	108	
415	12,521	10.7	31,151	28,523	10	28,533	8.4	132	121	6
416	393	3.6	1,459	1,130	329	1,459	0.0	56	56	0
417	647	5.7	2,280	1,982	none	1,982	13.1	114	99	7
418	550	6.6	736	595		595	19.2	67	54	5
419	1,054	8.6	2,838	2,541	none	2,541	10.5	159	142	7
420	480	18.5	491	404	8	412	16.1	90	75	9
421	180	7.2	623	574	none	574	7.9	131	121	6
422	257	4.8	935	708	142	850	9.1	170	155	4
423	303	9.5		602	none	602			97	
424	2,179	7.9	7,075					108		
425	2,027	7.7	3,698		7			107		
426	809	4.9	3,612					165		
427	178	5.4	641	511	130	641	0.0	103	103	0
428			3,336	2,502	125	2,627	21.2	229	180	19
429	445	10.3	971	962	9	971	0.0	177	177	0
430	512	10.2	583					94		
431	450	10.0	588	488	100	588	0.0	85	85	0
432	4,060	4.7	17,400	15,231	§			168		
433	3,987	7.9	14,326	12,458	none	12,458	13.0	212	184	10
434			5,232	4,957	70	5,027	3.9	130	125	2
435	4,406	10.8	11,467	9,533	287	9,820	14.4	151	129	11
436	1,325	6.6	2,706	2,123	260	2,383	11.9	84	74	4
437	1,078	5.5	3,456	3,117		3,117	9.8	113	102	5
438	350	6.7	556	514	1	515	7.4	59	55	3
439	324	6.7	614	529		529	13.9	105	91	5
440	363	5.8	441	345	2	347	21.3	47	37	4

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Trans- mission Mains miles	Distribution Mains—miles				Valves	
		4"-8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
441. Superior, Wis.	1.0	65	25	90	2.6	799	8.9
442. Swampscott, Mass.	0.8	32	9	41	3.4	432	10.5
443. Syracuse, N.Y.	54.3			367	1.5	7,156	19.5
444. Tacoma, Wash.		297	117	414	2.5	4,351	10.5
445. Tampa, Fla. <sup>10/55</sup>		†710	161	†871		5,000	5.7
446. Taunton, Mass.	6.8	93	30	123	3.1	1,192	9.7
447. Terrell, Tex. <sup>4/55</sup>	1.0	33	3	36	2.8		
448. Texarkana, Tex.	14.0	113	27	140	2.8	1,210	8.7
449. Texas City, Tex. <sup>7/55</sup>	2.0	26	0	26	0.9	663	2.6
450. Toledo, Ohio	12.0	555	121	676	1.5	5,100	7.6
451. Tonawanda, N.Y.							
452. Topeka, Kan.	0.2						
453. Torrance, Calif. <sup>7/55</sup>	4.0			110	2.4		
454. Torrington, Conn.	7.0	43	11	54	2.2	824	15.2
455. Tucson, Ariz. <sup>3/55</sup>	24.0	293	22	315	3.4	2,170	6.9
456. Tulare, Calif. <sup>7/55</sup>	47.6	†45	3	†48		961	
457. Tulsa, Okla. <sup>7/55</sup>	106.6	386	130	516	2.2		
458. Two Rivers, Wis.	1.2	12	2	14	1.3	550	
459. Uniontown, Pa.	0.0	51	25	76	3.0		
460. Vancouver, Wash.	4.8						
461. Ventura, Calif. <sup>7/55</sup>	3.4	59	27	86	2.8	2,000	23.2
462. Vernon, Tex. <sup>4/55</sup>	14.0	37	21	58	4.1	286	4.9
463. Vincennes, Ind.	1.5	30	7	37	1.5	628	17.0
464. Virginia, Minn. <sup>4/55</sup>	3.0	44	6	50	3.3	560	11.2
465. Walla Walla, Wash.	14.0			104	3.8	983	9.4
466. Wallingford, Conn.	9.0	45	20	65	2.8	500	7.7
467. Washington, D.C. <sup>7/55</sup>	24.0	895	343	1,238	1.5	16,723	13.5
468. Washington, Ind.	1.0	27	12	39	3.0	298	7.7
469. Washington C. H., Ohio*	2.1	29	1	30	2.3	237	7.9
470. Waterloo, Iowa	3.0	131	39	170	2.4	3,223	19.0
471. Watertown, N.Y. <sup>7/55</sup>	0.5	58	25	83	2.2	1,181	14.2
472. Watertown, S.D.	3.0	22	3	25	1.8	220	8.8
473. Waterville, Me.	8.0	45	30	75	2.5	869	11.6
474. Waukegan, Ill. <sup>5/55</sup>	1.0	99	35	134	2.7	1,948	14.5
475. Wauwatosa, Wis.		78	9	87	2.4	1,500	17.1
476. Waycross, Ga.		41	1	42	2.0		
477. Webster, Mass.				37	2.6	338	9.1
478. West Allis, Wis.		95	21	116	1.9	1,960	16.9
479. W. University Place, Tex.		16	3	19	1.0		
480. West View, Pa.		190	42	232	2.4	2,702	11.6

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. gpcdl	Distr. gpcdl	Loss per Main-Mile 1,000 gpd
	Total	Per Mile of Main		Sold	Free	Total				
441	1,018	11.1	1,296	895	*28	923	28.8	101	72	11
442	356	8.7	403		none			92		
443	5,369	14.6	17,317	9,620	\$			189		
444	2,694	6.5	19,917	18,190	\$			331		
445	2,800	3.2	8,051	8,051	none	8,051	0.0	94	94	0
446	1,210	9.8	1,816	1,247	\$			115		
447	200	5.6						68	62	2
448	543	3.9	1,252	1,153	none	1,153	7.9	82		
449	233	9.0	900					141	135	4
450	4,387	6.5	24,020	21,785	1,300	23,085	3.9	141	135	4
451			2,073	2,000	32	2,032	2.0	333	326	
452			4,466	3,823	\$			100		
453	728	6.6	3,927	3,556	21	3,577	8.9	240	218	9
454	330	6.1	1,500					164		
455	1,658	5.3	5,318	5,250	\$			155		
456	320		1,523					322		
457	2,403	4.7	15,593	12,770	946	13,716	12.0	160	141	10
458	225		520	462	none	462	11.1	129	115	11
459	31		749					82		
460	620		2,918					145		
461	850	9.9	2,028	1,727	18	1,745	13.9	179	154	9
462	287	4.9	537	427	110	537	0.0	105	105	0
463	351	9.5	804	696	none	696	13.4	92	80	8
464	263	5.3	788	538	\$			144		
465	435	4.2	3,503	2,200	none	2,200	37.2	356	223	35
466	410	6.3	964	948	16	964	0.0	115	115	0
467	8,336	6.7	57,515	49,297	3,153	52,450	8.8	151	138	11
468	318	8.1	438	352		352	19.6	92	74	6
469	282	9.4	347	265	1	266	23.4	73	56	7
470	1,650	9.7	2,998	2,448	180	2,628	12.3	116	101	6
471	615	7.4	1,698	1,148	90	1,238	27.1	122	89	15
472	298	11.9	480	363	6	369	23.1	94	72	12
473	362	4.8	1,703	1,703	none	1,703	0.0	156	156	0
474	1,295	9.7	2,493	2,324		2,324	6.8	139	129	4
475	1,006	11.5	1,335	1,203	none	1,203	9.9	99	89	4
476	500	11.9	641	450	50	500	22.0	84	65	10
477	307	8.3	403	389	14	403	0.0	79	79	0
478	1,260	10.9	2,433	2,006	none	2,006	17.6	108	89	9
479	288	15.1	741	584		584	21.2	113	89	24
480	1,171	5.1	2,901	2,221	none	2,221	23.4	84	64	8

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8
Community*	Transmission Mains miles	Distribution Mains—miles				Valves	
		4"-8"	10" & Over	Total	Per 1,000 Pop.†	Total	Per Mile of Main
481. Westchester County, N.Y.*	0.0	100	28	128	3.0	1,000	7.8
482. Westerly, R.I.				84	4.7	569	6.8
483. Westmoreland County, Pa. <sup>4/55</sup>	52.8			547	3.8		
484. Weymouth, Mass.	0.0	82	28	110	2.6	1,586	14.4
485. Whittier, Calif. <sup>7/55</sup>	24.2	82	7	89	2.8	1,579	17.8
486. Wichita, Kan.*	63.5	362	118	480	2.0	7,500	15.6
487. Wilkesburg-Penn, Pa.	2.0	257	66	323		5,591	17.3
488. Williamsport, Pa. <sup>7/55</sup>	1.5	113	31	144	2.4	1,871	13.0
489. Wilmington, N.C. <sup>7/55</sup>	28.0	84	29	113	2.1	784	6.9
490. Wilson, N.C. <sup>7/55</sup>	9.0	57	9	66	2.4	655	9.9
491. Winnetka, Ill. <sup>4/55</sup>	1.0	47	9	56	4.0	550	9.8
492. Wisconsin Rapids, Wis.	2.0						
493. Worcester, Mass.	5.0	253	189	442	2.1	6,876	15.6
494. Wyandotte, Mich. <sup>10/55</sup>	0.3	80	15	95	2.3	1,044	11.0
495. Yonkers, N.Y.	1.5	224	96	320	2.0	4,620	14.5
496. York, Pa.	6.0	176	47	223	2.2	2,800	12.6
497. Youngstown, Ohio	4.0	439	85	524	2.7	6,063	11.6

\* See notes beginning on p. 694.

† Includes mains less than 4 in. in diameter.

‡ Population served at retail.

1	9	10	11	12	13	14	15	16	17	18
	Hydrants		Production mil gal	Distribution—mil gal			Per Cent Prod. Un- accounted for	Prod. spcd	Distr. spcd	Loss per Main-Mile 1,000 spd
	Total	Per Mile of Main		Sold	Free	Total				
481	1,000	7.8	1,660	1,310		1,310	21.1	108	85	8
482	406	4.9	663					101		
483	1,123	2.1	7,781		none			146		
484	815	7.4	983	830	153	983	0.0	64	64	0
485	702	7.9	2,082	1,908	174	2,082	0.0	178	178	0
486	2,950	6.2	10,494	10,188	35	10,223	2.6	121	118	1
487	1,765	5.5	5,965	5,408	none	5,408	9.3	78	71	4
488	641	4.5	2,417	1,704	97	1,801	25.5	110	82	12
489	892	7.9	2,026	1,986	40	2,026	0.0	101	101	0
490	563	8.5	924	788	none	788	14.7	90	77	5
491	512	9.2	1,023	926	none	926	9.5	165	149	5
492			569	462		462	18.8	111	90	
493	4,296	9.7	8,634					114		
494	785	8.3	2,180	1,672	153	1,825	16.3	142	119	10
495	3,942	12.3	8,026	4,866	§			137		
496	822	3.7	5,962	5,353	none	5,353	10.2	163	146	8
497	4,642	8.9	8,718	6,588	2,130	8,718	0.0	119	119	0

§ Amount not known.

|| Based on total population served (retail plus wholesale).

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
1. Aberdeen, S.D.		5,529	162	0	17	5,708	97	0
2. Adrian, Mich. <sup>7/55</sup>	20	4,990	200	81	20	5,291	100	100
3. Akron, Ohio	257	68,300	4,500	450		73,250	100	
4. Albany, N.Y.						28,959	\$74	
5. Albemarle, N.C. <sup>7/55</sup>		3,800		5		3,805	100	
6. Albert Lea, Minn.						3,916	100	
7. Albion, Mich.								
8. Albuquerque, N.M. <sup>7/55</sup>						41,129	100	0
9. Alexandria, La. <sup>5/55</sup>		9,957				9,957	100	
10. Alhambra, Calif. <sup>7/55</sup>	25	†	15,517	135		15,652	100	
11. Allen Park, Mich.		9,340	250		12	9,602	100	100
12. Alliance, Ohio	22	†	7,936	67		8,003	100	
13. Amarillo, Tex. <sup>10/55</sup>	78	28,830		3,156	95	32,081	100	100
14. Americus, Ga.		2,900	100		4	3,004	100	0
15. Ames, Iowa	21	†	4,450	3	9	4,462	100	100
16. Anaheim, Calif.		14,738	521		29	15,288	100	100
17. Annapolis, Md. <sup>7/55</sup>	23							
18. Anniston, Ala. <sup>4/55</sup>	32	10,593	286	198	31	11,108	100	100
19. Ansonia, Conn.	15	†	3,142	30	21	3,193	100	100
20. Antioch, Calif. <sup>7/55</sup>		4,000	40	8		4,048	100	
21. Appleton, Wis.	30	10,994	612	176	62	11,844	100	100
22. Arcadia, Calif. <sup>7/55</sup>		10,755			39	10,794	100	100
23. Arlington, Va. <sup>7/55</sup>	70	26,296	*3,451			29,747	100	
24. Asheville, N.C. <sup>7/55</sup>							100	
25. Ashland, Ohio	15	5,215		12		5,227	100	
26. Athol, Mass.		2,450	34	44	17	2,545	98	100
27. Atlanta, Ga.	470	75,000	20,000	8,000	5,000	108,000	100	100
28. Atlantic City, N.J.	56					11,571	\$98	
29. Auburn, Me.	12	6,391	566	11	2	6,970	*2	100
30. Auburn, N.Y. <sup>7/55</sup>								
31. Augusta, Ga.								
32. Augusta, Me.		6,120	612	34	74	6,840	*28	100
33. Austin, Minn. <sup>3/55</sup>						7,088	100	
34. Austin, Tex. <sup>10/55</sup>						45,790	100	
35. Baltimore, Md.						299,658	\$60	
36. Bangor, Me.	43	9,205	860	36	9	10,110	*90	0
37. Barborton, Ohio	30	8,500	350	108	21	8,979	100	29
38. Batavia, N.Y.		4,400				4,400	100	
39. Baton Rouge, La.		42,000	4,025	25	50	46,100	100	100
40. Bay City, Mich. <sup>7/55</sup>		17,108	306	39	52	17,505	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>  </sup>	Min. Charge per Month \$	Penalty or Discount <sup>#</sup>	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
1	Q	1.33	P-5	333	2.73	19.68	168.40	1,518.40	none	none	0.75
2	M	1.00	N	400	2.40	17.60	136.10	1,036.10	25.00		
3	Q	1.33	D-10	667	1.97	18.73	148.73	1,275.40	none	none	0.00
4					1.80	18.00	180.00	1,800.00			none
5	M	1.00	N	200	3.40	21.60	138.60	1,338.60	none	none	1.00
6	Q	0.75	P, D	333	2.50	25.00	127.00	757.00			
7	Q	1.50	D-10	1,110	1.50	10.75	55.25	325.25	none	none	
8	M	1.50	P-\$1.00	667	2.15	17.55	135.29	1,271.77	none	none	
9	M	1.50		480	3.15	31.50	142.00	440.00			
10	B	1.00	P-\$1.00	600	1.60	16.00	118.00	1,018.00	none	none	1.00
11	Q	1.09	P-5	333	3.28	20.69	193.45				none
12	Q	1.25	P-10	333	3.75	21.81	145.33	1,006.09			
13	M	0.75	P-10	133	2.00	20.25	166.50	1,089.00	none	none	0.22
14	M	3.25	N	602	4.45	25.45	205.45	2,005.45	none	none	2.00
15	M	1.25	P-5	250	5.00	39.40	327.40	3,207.40	none	none	0.01
16	B	1.75		750	2.05	12.85	110.85	1,010.85			
17	Q	2.70	P-5	890	2.41	21.99	217.74	2,175.24			none
18	Q	1.60	N		3.00	21.50	101.40	821.40	*		0.80
19	Q	2.40	N	0	5.50	33.00	264.10	1,874.10	10.00	48.58	0.08
20	M	1.75	N	700	2.35	20.70	152.85	1,502.85			0.75
21	Q	0.84	P-10	333	2.13	18.43	123.10	886.10			none
22	B	2.50	P-10	1,600	1.41	9.11	82.36	807.36			
23	Q	0.50	D-5	0	1.91	16.53	162.73	1,624.78	none	none	0.01
24	M	1.54	N	300	4.80	39.00	225.75	1,050.75	none	none	0.00
25	Q	0.92	P-10	267	3.45	30.79	212.83	1,922.83	none	none	
26	Q	1.50	*D	333	3.30	17.00	136.50	1,330.00	none	none	none
27	M, B	1.25	P-\$0.32	800	1.91	30.25	187.97	1,298.00	none	none	none
28	A	1.08	P-10	985	1.10	11.00	110.00	1,100.00	none	none	none
29	Q	1.08	N	1,388	1.25	6.33	42.33	402.33	none	none	0.06
30	Q	1.50	P-10	500	3.00	24.60	164.40	1,054.40	*35.00		
31					2.78	25.06	225.30	1,636.80	none	none	
32	Q, SA	1.42	N	833	1.67	11.30	68.50	208.00	*		none
33	M	0.75	P-5	200	1.96	12.05	111.05	1,101.05	10.00		<1
34	M	0.50	N	200	2.58	17.45	118.95	1,063.95	none	none	0.00
35	Q	0.83	N	333	2.50	16.67	110.00	1,030.00	*10.00		none
36	Q	0.50	N	500	1.00	4.33	35.66	277.66	30.00		none
37	Q	1.10	D-10	533	2.06	17.88	122.25	965.50	none	none	
38	Q	1.00	P-10	445	2.25	17.30	165.80	1,650.80			none
39		1.25	D-10		3.00	30.00	148.00	973.00			0.18
40	Q	0.67	P-10	0	2.07	15.33	112.00	1,038.66	33.65		none

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

\* Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

† No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
41. Beaver Falls, Pa.		13,622	761	110	77	14,570	*90	79
42. Beckley, W.Va.	35	10,168	809	7	83	11,067	100	100
43. Bellaire, Ohio							0	0
44. Bellaire, Tex. <sup>10/55</sup>		6,400	113		18	6,531	100	100
45. Bellingham, Wash.	45	9,976	1,231	101		11,308	0	
46. Belmont, Mass.	21					6,428	100	
47. Bemidji, Minn.		1,275	145	6	12	1,438	100	33
48. Benton Harbor, Mich.		4,668	528	75		5,271	100	
49. Berlin, N.H.		3,256	80	77	20	3,433	*10	65
50. Beverly Hills, Calif. <sup>7/55</sup>	55	10,010				10,010	100	
51. Bexley, Ohio <sup>11/55</sup>	3	4,000	50			4,050	100	
52. Billings, Mont.	71	11,410	1,104	28	93	12,635	100	100
53. Binghamton, N.Y.	64	13,121	1,578	236	37	14,972	100	100
54. Birmingham, Ala.	205	84,940	12,329	316	866	98,451	100	51
55. Birmingham, Mich. <sup>7/55</sup>	7					7,150	100	
56. Bismarck, N.D. <sup>7/55</sup>	13	4,505	420		44	4,969	99	100
57. Bloomfield, N.J.	18					10,588	100	
58. Bloomington, Ill. <sup>5/55</sup>	40					10,264	100	
59. Boone, Iowa	15	3,929	49	1		3,979	100	
60. Boston, Mass.	400					96,436	100	
61. Boulder, Colo.		5,825	890	†	10	6,725	7	100
62. Braddock, Pa.	18	1,578	329	10	1	1,918	90	0
63. Bradenton, Fla.						5,487	100	
64. Bradford, Pa.	19	5,960	162	35		6,157	9	
65. Brawley, Calif. <sup>7/55</sup>	40	1,975	465	35	25	2,500	*9	0
66. Bremerton, Wash.		10,854		4		10,858	91	
67. Bridgeport, Conn.	292	56,972		496	272	57,740	43	100
68. Bristol, Tenn. <sup>6/55</sup>								
69. Bristol, Va.	22	3,690	739	†		4,429	100	
70. Brockton, Mass.	65							
71. Brookline, Mass.		8,818	565		200	9,583	100	100
72. Brownsville, Tex.	33					8,795	100	
73. Buffalo, N.Y.	360	88,967	11,202	1,160	420	101,749	8	100
74. Burbank, Calif. <sup>7/55</sup>		22,243	2,201	280	82	24,806	100	100
75. Burlington, Iowa	30	9,107	991	†	8	10,106	0	0
76. Burlington, N.J.	13	3,444	526	11	25	4,006	0	0
77. Burlington, N.C. <sup>7/55</sup>	58	7,406	690	121	16	8,243	99	88
78. Butte, Mont.		†	12,829	250	85	12,964	‡8	60
79. Cambridge, Ohio	18	4,660	155	48	11	4,874	100	0
80. Canton, Ohio		35,992	492	†		36,484	100	

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
41	Q	1.20	P-10	133	4.17	25.63	183.66		7.00	400.00	
42	M	1.25	D-5	267	4.15	27.90	200.90	1,562.90	50.00	none	0.50
43	Q	1.42	P-10								
44	M	1.75	P-10	667	2.50	22.75	225.25	2,250.25	none	none	0.04
45	B	1.50	P-\$0.25	¶	1.75	8.95	56.95	326.95	18.00	none	none
46	Q	0.83	N	267	.95	6.20	58.70	583.70			none
47	Q	0.80	D-10	267	3.00	17.30	82.50	825.00			
48	M	2.00	N	500	2.90	17.30	121.00	871.50			none
49	Q	2.08	N	¶	3.33	21.53	120.53	1,020.53			none
50	B	1.80	N	1,000	1.80	18.00	129.00	1,209.00			0.02
51	SA	0.00	P-10	0	1.87	18.70	187.00	1,870.00			1.00
52	M	1.30	N	400	2.97	14.04	105.84	672.84	30.00		0.08
53	A	0.90	P-5	500	1.70	14.50	97.30	907.30			0.20
54	Q	1.09	N	444	2.45	24.50	161.65	880.15	30.00	none	0.42
55		0.67	P-5	0	2.17	16.00	133.00	1,312.00	18.50	none	none
56	M	2.45	N	280	4.95	33.66	245.73	2,135.73	none	none	0.00
57		0.68			2.60	24.40	189.31	1,818.31			
58		1.50	N	250	6.00	43.60	223.60	1,343.60			1.50
59	Q	0.67	P-10	207	2.90	16.40	91.40	811.40	none	none	0.25
60	Q		N	167	*2.00	*19.67	*173.34	*766.67	none	none	2.00
61	Q	0.67		445	1.87	18.75	113.75	1,137.50	22.50		none
62	Q	0.45	P-10	167	*2.25	*21.69	*148.14	*1,201.14			
63	M	2.00	N	400	4.00	23.25	306.95	3,006.95			1.00
64	Q	1.67	P-\$0.50	533	3.30	15.75	97.50	669.75			0.03
65	M		P-\$0.50		0.98	9.75	84.00	759.05			<1
66	M, B	2.40	P-\$0.25	800	2.40	15.10	150.60	1,500.60			0.01
67	Q	0.00	N	0	2.95	23.88	141.88	1,076.87	10.00	73.92	0.02
68		1.00	D-10	267	2.38	15.50	84.25	624.25			
69	M	1.25	P-10	267	3.73	27.35	173.60	1,192.35	60.00		0.04
70	Q				2.05	18.90	126.90	1,206.90	none		
71	Q	0.00		0	2.10	21.00	210.00	2,100.00			none
72	M	1.25	P-10	533	2.13	13.96	108.46	1,053.46			2.00
73	Q, SA	1.10	N	1,000	1.10	9.46	62.26	584.26	15.00		
74	B	1.35	N	700	1.75	14.30	117.30	847.30			0.00
75	Q	0.83	N	¶	2.75	20.55	130.10	1,012.60	none	none	2.00
76	A	0.83	D-10	¶	3.00	30.00	190.00	1,155.00	*20.00		none
77	M	1.50	N	400	3.53	29.40	193.15	1,218.15	25.00	none	
78	M	1.50	N	300	2.90	17.75	125.00	1,100.00			
79	Q	1.33	N	445	1.33	6.92	43.17	380.67	none	none	0.50
80	Q	0.83	P-10	667	0.90	8.55	69.60	677.10	none	none	

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

¶ No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
81. Cape Girardeau, Mo.		5,642	677		14	6,333	100	100
82. Carthage, Mo. <sup>7/88</sup>								
83. Cedar Falls, Iowa		4,591	84		14	4,689	100	100
84. Cedar Rapids, Iowa	70	20,972	428		32	21,432	100	100
85. Chambersburg, Pa.	39	4,337	264	40	45	4,686	100	100
86. Champaign, Ill.*	35	13,884	1,055	81	39	15,059	100	100
87. Charleroi, Pa.		9,745	421	41	50	10,257	100	100
88. Charleston, S.C.	105	23,994		552		24,546	100	
89. Charleston, W.Va.		43,089	2,531	365		43,985	100	
90. Charlotte, N.C. <sup>7/88</sup>						51,000	100	
91. Chicago, Ill.	2,728					474,414	\$28	
92. Clarksburg, W.Va.		7,450	868	37	43	8,398	100	100
93. Clarksdale, Miss. <sup>10/88</sup>	15				36	4,900	100	100
94. Cleburne, Tex. <sup>10/88</sup>						5,653	100	
95. Cleveland, Ohio		†	253,223	6,710	380	*261,296	100	100
96. Clinton, Iowa		7,934	669	63	29	8,695	*98	100
97. Cobb County, Ga.	11					*	100	
98. Coffeyville, Kan.	28					6,194	100	
99. Collinsville, Ill.		5,073	66			5,139	100	
100. Colorado Spgs., Colo.	65	18,945	2,727	40	28	21,740	100	100
101. Columbia, Mo. <sup>10/88</sup>						7,570	100	
102. Columbia, S.C. <sup>7/88</sup>						18,553	100	
103. Columbia, Tenn. <sup>7/88</sup>		4,807	589	12		5,408	*100	
104. Columbus, Miss.						4,587	100	
105. Concord, N.H.	29	†	5,468	11	114	5,593	\$95	0
106. Corpus Christi, Tex. <sup>8/88</sup>		34,163		5,272	24	39,459	100	100
107. Coshocton, Ohio						4,050	100	
108. Council Bluffs, Iowa	65	12,999	362	415	25	13,786	100	60
109. Covington, Ky.	65	1,373		41	5	1,419	100	100
110. Crawfordsville, Ind.		3,583	613	38	33	4,267	100	100
111. Cudahy, Wis.		2,630	257	25		2,912	100	
112. Cuyahoga Falls, Ohio		11,712	578	13	14	12,317	100	100
113. Dallas, Tex. <sup>10/88</sup>		149,039	13,274	83	294	162,690	100	100
114. Danville, Va.	47	9,060	894	112	51	10,117	100	100
115. Dayton, Ohio		64,800	3,600	3,300	300	72,000	100	100
116. Dearborn, Mich. <sup>7/88</sup>	33					30,406	100	
117. Decatur, Ala. <sup>8/88</sup>	15	5,929	696	12	8	6,645	100	100
118. De Kalb, Ill. <sup>8/88</sup>	5	3,564	384	46	25	4,029	100	100
119. De Kalb County, Ga.						44,000	100	
120. Denison, Tex. <sup>8/88</sup>	25	5,846	354	12		6,212	100	

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>1</sup>	Min. Charge per Month \$	Penalty or Discount <sup>2</sup>	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
81	M	1.25	P-5	333	3.75	32.00	154.60	1,369.60	*		
82	M	1.50	P-5	300	4.50	32.50	222.50	2,022.50			
83	M	1.00	P-10	330	3.00	21.00	106.03	871.03	none	none	none
84	B	1.25	D-5	500	2.60	22.00	157.00	1,957.00			0.05
85	Q	0.75	P-10	500	1.50	15.00	66.00	453.60	50.00		none
86	Q	1.20	P-2	234	4.38	27.58	122.08	842.08	20.00		0.20
87	Q	1.67	P, D	445	4.75	34.50	145.65		25.00	200.00	
88	Q	1.00	N	500	2.00	19.00	158.67	1,180.11	none	none	
89	M	1.40	N	267	4.40	34.32	183.82	1,308.82			0.25
90	M	1.00	N	300	2.67	25.07	94.67	671.87	none	none	0.60
91	M, B		D-5		0.90	9.00	90.00	900.00	none	none	
92	B	1.30	P-\$0.25	400	3.25	27.40	175.40	1,570.40	none	none	0.00
93	M	1.00	N	400	2.25	15.75	86.50				1.00
94	M	1.35	P-10	240	3.05	22.05	158.30				0.00
95	Q	0.50	P-3	333	0.99	7.82	73.82	710.42			
96	Q	1.81	N	372	4.88	29.22	186.60	1,290.00			
97											
98	M	1.50	P-5	533	2.72	23.60	193.60	1,171.10	none	none	2.00
99	Q	1.50	P-15	267	5.63	37.13					1.00
100	M	1.50	N	500	2.30	16.70	153.00	1,300.00			0.03
101	M	0.60	P-5	200	2.75	21.25	201.25	2,001.25			0.00
102	M	1.50	N	600	2.30	19.50	181.50	1,621.50			
103	M	1.00	N	333	3.00	21.90	136.00	1,050.00	*		0.97
104	M	1.50	P-10	400	3.30	23.30	135.80	1,080.00	none	none	0.00
105	Q	1.03	P-10	500	1.98	14.92	105.08	738.59	none	none	none
106	M	1.00	N	400	2.48	21.20	135.00	1,010.00	none	none	
107	Q	1.00		333	2.50	14.00	121.00	1,001.00	none	none	1.00
108	B	0.80	P-10	200	3.70	26.20	187.20	1,717.20	none	none	0.00
109	Q	1.03		267	2.47	18.47	127.13	1,207.13	none	none	0.14
110	M	2.00	P-10	427	4.58	30.85	188.60	1,213.60	75.00		0.22
111	Q		P-5	0	3.27	18.08	140.80	1,054.00	12.00	528.00	none
112	Q	1.20	N	625	1.90	18.00	143.50	1,142.50	none	none	none
113	M	1.00	P-10	133	2.78	18.30	146.55	994.05			0.27
114	M	1.20	P-10	600	2.00	18.80	88.30	673.30			0.13
115	Q	0.70	P, D	333	1.70	13.75	105.00	619.00			0.50
116	Q	0.62	P-5	333	1.38	11.40	110.40	1,003.73	15.00		none
117	M	2.00		533	3.75	23.13	112.00	528.75			
118	Q	0.50	D-10	100	1.75	12.40	62.45	502.33			none
119	M	2.00	D-10	800	2.60	29.60	299.60				2.20
120	M	1.25	P-\$1.00	140	4.10	23.20	146.50	1,231.50	none	none	0.01

<sup>1</sup> Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

<sup>2</sup> Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
121. Denton, Tex. <sup>6/55</sup>		6,093	870	6	54	7,023	100	100
122. Denver, Colo.	650	98,572	15,578	575	278	115,003	5	100
123. Derby, Conn.		1,716	186	57	13	1,972	*20	100
124. Des Moines, Iowa	190					56,559	100	
125. Des Plaines, Ill.		6,500	200	25	12	6,737	100	100
126. Detroit, Mich. <sup>7/55</sup>		360,246	31,895	2,316	912	395,369	100	100
127. Dodge City, Kan.	10						100	
128. Dover, N.J.	18	†	3,790	20	10	3,820	100	100
129. Dubuque, Iowa	31						100	50
130. Duluth, Minn.						23,803	100	
131. Durant, Okla. <sup>7/55</sup>	14					3,100	100	
132. Durham, N.C. <sup>7/55</sup>	133					19,426	100	
133. Dyersburg, Tenn. <sup>7/55</sup>								
134. E. Bay M.U.D., Calif. <sup>7/55*</sup>	1,150	228,528	17,435	1,038	1,081	248,082	100	100
135. East Detroit, Mich. <sup>7/55</sup>	14	10,403	475		10	10,888	100	100
136. East Jefferson, La.	109					23,448	100	
137. East Lansing, Mich. <sup>7/55</sup>	8	†	2,685		3	2,688	100	100
138. East Orange, N.J.		9,753	825	18	52	10,648	100	100
139. Eau Claire, Wis.	35	8,460	749	69	37	9,315	100	43
140. Ecorse, Mich. <sup>7/55</sup>		3,707	99	†		3,806	100	
141. El Centro, Calif.								
142. El Dorado, Kan.	32					4,600	100	
143. Elizabeth, N.J.	44					17,615	100	
144. Elizabeth City, N.C. <sup>7/55</sup>						4,312	100	
145. Elmira, N.Y.	70	16,820		238	100	17,158	100	100
146. Elwood, Ind.	10	†	3,123	35	14	3,172	100	100
147. Emporia, Kan.	14	4,779	504	†		5,283		
148. Endicott, N.Y.						8,374	100	
149. Erie, Pa.	186	33,154	3,596	926	19	37,695	*1	74
150. Escanaba, Mich. <sup>7/55</sup>						4,190	100	
151. Eugene, Ore.	44	8,381	2,296	†	88	10,765	100	100
152. Evanston, Ill.	45	12,059	874	†		12,933	100	
153. Fargo, N.D. <sup>7/55</sup>		8,672	896		1	9,569	100	0
154. Faribault, Minn.		2,978	323	38	27	3,366	100	0
155. Fayetteville, N.C. <sup>7/55</sup>		11,277	1,395		4	12,676	100	75
156. Fergus Falls, Minn. <sup>4/55</sup>	14						100	
157. Flint, Mich. <sup>7/55</sup>		49,996	650	†	100	50,746	100	100
158. Florence, Ala. <sup>30/55</sup>	21	7,053	858			7,911	100	
159. Fort Collins, Colo.		4,453	2,149	†	12	6,614	0	0
160. Fort Dodge, Iowa	30	6,954	645	68	34	7,701	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>1</sup>	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
121	M	2.50	N	500	4.15	25.90	208.30	2,030.80			0.00
122	Q	1.05	P-\$1.00	400	1.97	15.21	118.71	909.96	22.50	none	none
123	Q	1.11		167	2.72	18.51	154.68	923.34	none	48.58	none
124	Q	0.67		222	3.00	24.00	124.00	988.80	none	none	0.33
125	Q	1.50	N	67	3.30	33.00	220.00	1,650.00			
126	Q	0.55	P-5	300	1.16	9.92	79.16	644.84	none	none	0.00
127		1.25	P-10	533	3.55	15.05	116.30	1,128.80	none	none	0.00
128	Q	1.11	D-10	333	3.33	27.75	184.75	1,113.75	50.00		<1
129	Q	1.08	N	300	3.60	23.10	176.10	1,121.10			
130	M	0.75	N	347	2.00	20.00	124.00	1,114.00	19.00		0.03
131	M	1.50	P-10	400	3.25	21.90	143.40	1,223.40			1.00
132	M	1.50	N	500	2.85	27.15	177.15	437.50	*30.00		0.03
133	M	1.00	P-10	133	3.32	24.31	126.66	867.18		none	0.36
134	B	1.60	N	300	3.00	21.16	155.64	1,120.63	*		0.15
135	Q	0.92	P-5	500	1.52	11.72	110.72	1,100.72	none	none	none
136	B	1.50	P-10		3.00	26.75	201.75	1,888.25			
137	Q	1.20	D-10	400	3.60	20.52	182.52	1,862.52	20.00		none
138	Q	0.80	P-1	333	2.40	24.00	223.33	2,203.33	none	none	none
139	Q	1.00	P-5	267	2.47	6.13	36.30		20.00	*	none
140	Q	0.67	P-10	445	2.00	15.00	150.00	1,500.00			none
141	M	3.50	P-\$2.50	3,333	3.50	10.00	95.25	905.25			
142	M	2.30	P-5	300	5.75	37.25	90.00		none	none	none
143	Q	1.00	N	400	2.50	21.50	183.50	570.17	none		1.00
144	M	0.67	N	133	5.03	33.75	164.90	1,177.40			0.50
145	Q	1.17	D-10	333	2.55	12.60	85.50	614.50	50.00		
146	M	1.60	P-10	400	3.76	29.76	174.76	804.76	6.00		
147	M	0.65	P-\$0.25	133	2.47	17.07	99.62	782.62	none	none	0.07
148	Q	1.50	D	400	3.75	25.98	145.23	737.73	90.00		0.00
149	Q	1.20	P-5	750	1.60	7.80	54.60	522.60	*57.50		none
150		1.00	P-5	0	3.48	19.00	111.10		40.00		
151	M	1.15	N	400	1.99	8.79	72.94	712.24			0.10
152	Q	1.00	P-10	467	2.10	17.00	118.66	1,108.66	none	none	none
153	Q	0.42	P-10	0	2.25	22.50	182.50	1,272.50			
154	Q	0.50	D-20	167	2.40	8.00	80.00	800.00			1.00
155	M	1.00	N	400	2.35	18.10	120.60	1,133.10	none	none	
156	B	0.60	P-10	0	2.10	16.60	159.60	825.00	30.00		0.20
157	Q	1.12	P-10	400	2.20	15.15	106.15	916.15	5.00		none
158		1.50	P-10	267	4.21	24.40	144.65	1,159.65			0.13
159	Q	3.22	N	†	2.70	15.50	100.80	845.80			none
160	Q	0.53	D-10	178	2.43	11.59	57.27	482.52	none	none	

† Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

\* Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

† No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Em- ployees	Customers					Resid. Svcs. Me- tered %†	Public Svcs. Me- tered %‡
		Resid.	Coml.	Ind.	Public	Total		
161 Fort Madison, Iowa						3,789	100	
162. Fort Scott, Kan.								
163. Fort Wayne, Ind.	173	36,213	4,252		110	40,575	100	100
164. Fostoria, Ohio	10	4,500	125	†		4,625	100	
165. Frankfort, Ky. <sup>7/55</sup>		4,438	1,115	†		5,553	100	
166. Franklin, Ind.		2,219	325	7	20	2,571	100	100
167. Franklin, Pa.		5,003	339	22	6	5,370	90	0
168. Fredericksburg, Va. <sup>7/55</sup>	5	3,454	200	20		3,674	26	
169. Freeport, Ill. <sup>10/55</sup>	30					7,333	100	
170. Fremont, Neb.						5,108	100	
171. Fresno, Calif. <sup>7/55</sup>		†	42,413			42,413	14	
172. Fullerton, Calif. <sup>7/55</sup>	45							
173. Fulton, Mo. <sup>7/55</sup>	7	1,958	269	6		2,233	100	
174. Gainesville, Ga.						5,278	100	
175. Garden City, N.Y. <sup>3/55</sup>						5,545	100	
176. Gary, Ind.	131	28,475	3,119	73	108	31,775	100	98
177. Gastonia, N.C. <sup>7/55</sup>								
178. Glen Cove, N.Y.	11	†	4,643	60	40	4,743	100	68
179. Glendale, Calif. <sup>7/55</sup>						28,234	100	100
180. Gloversville, N.Y.	19					5,695	100	
181. Goldsboro, N.C.		6,304	50	60		6,414	98	
182. Goshen, Ind.	28					3,540	100	
183. Grand Island, Neb. <sup>8/55</sup>		7,192	64	2		7,258	100	
184. Grand Junction, Colo.	21	7,105	1,150	27		8,282	100	
185. Grand Rapids, Mich. <sup>7/55</sup>								
186. Great Bend, Kan.		5,304	808		5	6,117	100	100
187. Green Bay, Wis.	25	13,423	1,167	121	137	14,848	100	100
188. Greensboro, N.C. <sup>7/55</sup>	80	21,500	1,500	†		23,000	100	
189. Greenville, Miss. <sup>10/55</sup>	32	8,500	520	50	22	9,092	100	0
190. Greenville, N.C. <sup>7/55</sup>		5,021	840	7	19	5,887	100	100
191. Greenville, S.C. <sup>8/55</sup>	62	28,453	2,201	126	45	30,825	100	100
192. Greenwood, Miss. <sup>10/54</sup>						5,042	100	
193. Greenwood, S.C.		†	4,175	67	7	4,249	100	100
194. Griffin, Ga. <sup>12/54</sup>		4,086	897	†		4,983	100	
195. Haddonfield, N.J.							100	
196. Hagerstown, Md.								
197. Hamilton, Ohio	65	16,343	1,434	120		17,897	100	
198. Hammond, Ind.	75	23,855		737		24,592	100	
199. Hannibal, Mo. <sup>6/55</sup>	47					6,514	100	
200. Hanover, Pa.	19	6,148	415	97	18	6,678	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>  </sup>	Min. Charge per Month \$	Penalty or Discount <sup>#</sup>	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
161	M	1.00	P-\$1.00	267	3.63	17.75	91.75	766.75	40.00		0.01
162		1.40	P-10	400	3.50	31.50	185.50	1,097.50			0.00
163	M	1.40	N	500	2.45	17.85	124.05	846.55	40.00		0.11
164	Q	0.80	P-5	100	2.60	18.58	113.39	788.39			
165	M	1.00	P-10	440	2.00	13.00	97.75	537.75	10.00		0.01
166	M	2.30	P-10	455	4.48	31.15	179.40	1,259.40	75.00		0.25
167	Q	1.50	P-5	333	3.00	18.42	74.67				
168	Q	1.50	N	445	2.87	16.20	100.00	819.90	50.00		1.50
169	M, B	0.88	P-10	220	4.00	33.60	131.20	1,031.20	11.22	39.60	0.10
170	M	0.75	N	700	1.10	7.80	52.80	412.80			
171	B	1.60	P-\$2.00	500	2.30	11.95	66.61	480.11	3.00		
172	B	1.50	P-\$1.00	667	1.85	10.40	70.20		15.00		
173	M	0.50	N	150	3.50	27.50	252.50		none	none	0.50
174	M	1.35	N	300	4.50	40.00	230.80	2,120.80	none	none	
175	Q	1.38		667	2.06	19.06	155.19				
176	B	1.59	P-10	400	3.26	18.88	109.38	919.38	75.00		0.08
177	M	1.35	P-\$0.50	400	3.38	29.25	193.00	1,093.00	none	none	2.00
178	M, Q	1.30	N	400	3.10	22.10	157.10		40.00		0.00
179	M, B	1.00	N	588	1.70	17.00	135.00	760.00	24.00		0.06
180	SA	0.67	D-10	267	2.41	10.58	71.91	411.91	none	none	none
181	Q	0.72	P-\$0.33	100	3.10	22.65	158.33	1,469.00	none	none	0.10
182	M	0.70	P-10	500	1.25	9.00	60.20	420.20			
183	Q	0.50	D-10	500	1.50	9.40	81.40	631.40			none
184	Q	1.50		400	2.82	17.59	122.59		none	none	
185	Q	0.60	P-10	0	1.43	9.08	80.33	730.00	30.00		
186	M	1.50	P-5	400	2.75	14.80	65.45	537.95	40.00		
187	Q	0.42	P-5	0	1.67	11.05	85.55	692.55			none
188	M, Q	1.00	N	300	2.90	22.74	166.74	1,306.74			none
189	M	1.75	N	535	2.51	16.56	100.75	764.85	none	none	0.10
190	M	1.50	N	400	2.70	13.10	87.58	807.58			1.00
191	Q	1.00	N	357	2.60	17.05	125.47	836.30	none	none	1.00
192	M	1.25	N	667	1.69	11.15	70.15				0.05
193	M	1.00	N	445	2.50	20.75	100.75		none	none	0.01
194	M	1.40	P-\$0.50	467	3.00	22.00	142.00	1,062.00	none	none	2.00
195	SA	1.00	P-6	445	2.25	22.50	225.00	2,250.00			none
196		1.00	N	445	2.25	19.50	151.50	1,366.50	50.00		0.56
197	M	0.90	N	225	4.00	27.40	241.40	2,221.40	none	none	none
198	Q	1.20	P-\$0.10	667	1.64	15.00	110.00	987.50	50.00		none
199	Q	1.00	P-10	300	3.37	8.75	57.91	363.40			0.10
200	Q	1.00	P-10	90	3.70	15.25	103.25	980.75	25.00		none

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
201. Harlingen, Tex.	31	5,150	1,100	20	38	6,308	100	100
202. Hartford, Conn.*	379					57,750	96	
203. Hastings, Neb.					14	6,003	100	100
204. Haverstraw, N.Y.	11	†	3,161	37	32	3,230	100	66
205. Helena, Ark.	12	2,029	394	†	25	2,448	100	100
206. Hibbing, Minn.						5,223	89	
207. Highland Park, Mich. <sup>7/55</sup>		7,195	826	57	7	8,085	100	100
208. Hilo, T.H.*	49					7,346	100	
209. Holland, Mich.						4,693	100	
210. Hollywood, Fla. <sup>10/55</sup>	42					10,885	100	
211. Honolulu, T.H.		32,574	5,610	306	490	38,980	100	100
212. Hopkinsville, Ky. <sup>8/55</sup>	38	4,962	647	29	43	5,681	100	100
213. Hoquiam, Wash.		3,490		30	28	3,548	97	100
214. Hot Springs, Ark.		7,752	2,171	15	16	9,954	100	100
215. Houston, Tex.	700	†	158,520	5	345	158,870	100	100
216. Huntington Pk., Calif. <sup>7/55</sup>	18						100	0
217. Hutchinson, Kan. <sup>3/55</sup>	15					10,367	100	
218. Independence, Kan.	25					4,300	100	0
219. Independence, Mo.	74	19,763	962	28	14	20,767	100	100
220. Indianapolis, Ind.	354	113,500	7,145	1,160	302	122,107	100	30
221. Ironton, Ohio <sup>9/55</sup>						4,966	100	
222. Ithaca, N.Y.	40					6,425	100	100
223. Jackson, Mich. <sup>7/55</sup>		13,750	375	†		14,125	100	
224. Jacksonville, Fla.	200					63,678	100	
225. Jacksonville, Ill.	12					5,357	100	
226. Jamaica, N.Y.	222	99,765	8,887	†		108,652	3	
227. Jamestown, N.Y.	39	11,809	1,028	212	89	13,138	*100	94
228. Janesville, Wis.	12	7,252	522	106	30	7,910		
229. Jefferson City, Mo.	27	5,694	770	19	30	6,513	100	100
230. Jeffersonville, Ind.		6,506	681	17	49	7,253	100	100
231. Johnson City, N.Y. <sup>9/55</sup>								
232. Johnstown, N.Y.	7	2,570	454	†		3,024	0	
233. Jonesboro, Ark.						5,068	100	
234. Junction City, Kan.		3,596	146			3,742	100	
235. Kalamazoo, Mich.						21,280	100	
236. Kankakee, Ill.		9,306	900	45		10,251	100	
237. Kansas City, Mo. <sup>8/55</sup>	530	82,565	14,578	247	3	97,393	100	100
238. Kearney, Neb.		2,864	375		30	3,269	100	100
239. Kennewick, Wash.		4,653	622	†		5,275	100	
240. Kenosha, Wis.		13,558	1,225	108	101	15,098	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
201	M	1.75	N	560	2.85	16.00	123.75	1,068.25	35.00		0.70
202	SA	0.63	P-5	267	2.30	21.70	192.15	1,092.15	5.00		none
203	M	1.00	N	770	1.30	8.75	57.05	507.05	none	none	0.00
204	M, Q	1.86	N	400	4.65	43.80	235.30		96.00		0.00
205	M, Q	1.25	P-10	300	3.50	29.40	122.40	797.40	50.00		0.00
206	M	1.74	P-5	667	2.33	22.00	171.50	1,656.50			
207	SA	0.33	P-5	333	1.00	6.85	65.35	650.35	none	none	none
208	M	1.00	P-10	0	3.10	22.00	197.00	1,735.00			
209	Q	1.60	D-10	333	3.00	21.60	153.81		40.00		0.01
210	M	1.50	N	533	2.89	29.80	234.18	2,252.70	none	none	none
211	M	1.00	N	0	3.25	20.50	144.00	1,017.00			0.05
212	M	1.50	N	295	5.00	38.50	191.17		30.00		0.28
213	B	1.40		330	4.23	31.35	92.83	709.33			0.10
214	M	1.00	P-10	307	3.30	29.25	183.25		20.50		0.01
215	B	1.50	P-5	400	3.21	25.38	175.84	1,030.84	none	none	0.01
216	M	1.50	N	1,000	1.50	15.00	150.00	1,500.00	none	none	0.40
217	M	1.00	P-2	500	2.00	14.50	72.00	387.00			<1
218	M	1.00	P-10	200	2.80	17.30	119.80	827.30	none	none	<1
219	Q	1.73	N	267	5.03	38.93	258.26	1,984.93	41.00		0.03
220	M, B	2.22	N	500	3.87	29.02	178.22	1,078.22	12.00	58.61	0.10
221	Q	1.00	P-10	133	3.15	20.90	164.40	1,514.40			none
222	Q	0.00	P-10	0	2.06	13.67	107.00	910.00	*75.00		none
223	Q	0.96	P-10	300	1.90	12.85	68.50	321.00			none
224	Q	1.00	N	800	1.50	12.00	71.75	409.25	25.00		0.21
225	M	1.00	N	133	5.37	38.02	198.02	1,750.52	none	none	1.00
226	Q	1.80	N	400	2.50	19.15	160.90	1,578.40	47.00		0.00
227	Q	0.53	P-10	267	2.00	20.00	200.00		*35.00		none
228	Q	0.53	P-10	333	1.43	11.92	59.85	244.95	45.00		none
229	M	1.00	N	200	3.72	31.57	251.02		50.00		
230	M	2.00	P-10	480	3.95	29.25	162.75	1,115.25	90.00		0.23
231	SA	0.67	P-5	450	1.49	10.82	54.99	459.99			none
232	SA	0.70	P-2, 5	250	2.40	7.66	44.95	359.95	none	none	none
233	M	0.90	N	400	2.84	17.56	77.46	619.86			0.10
234	M	1.00	N	300	3.00	26.00	260.00	2,600.00	none	none	0.50
235	Q	0.50	*P	0	1.90	12.33	106.66	694.66	35.00		0.00
236	M	2.10	P-10	400	4.98	37.92	175.32	1,047.02	52.00		0.25
237	B	1.00	P-5	370	2.70	27.00	270.00	2,700.00			0.04
238	B	1.00	N	650	1.21	6.61	60.61	600.61	none	none	0.15
239		2.50	N	495	3.50	10.70	73.70	703.70	15.00		
240	SA	0.83	P-10	333	1.63	12.43	105.60	729.77			none

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

\* Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

¶ No limit; flat rate to most or all residential users.

Ⓢ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
241. Kent, Ohio	10	3,550	26	16		3,592	100	
242. Keokuk, Iowa		5,500	200	25	37	5,762	100	67
243. Key West, Fla. <sup>9/88*</sup>	50					100	100	
244. Kirksville, Mo.	10					100	100	
245. Klamath Falls, Ore.	20	7,147	862	19	46	8,074	100	30
246. Knoxville, Tenn.	218					38,658	100	
247. Laconia, N.H.		2,192	885	†	38	3,115	*99	89
248. La Crosse, Wis.		10,670	1,077	113	95	11,955	100	51
249. Lafayette, La. <sup>10/88</sup>	49					10,176	100	100
250. Lake Worth, Fla. <sup>11/88</sup>	10	5,393	121		33	5,547	100	100
251. Lakeland, Fla. <sup>9/88</sup>	19				70	13,922	100	100
252. Lakewood, Ohio		14,173	375	68	80	14,696	100	66
253. La Mesa, Calif.*	130					21,344	100	
254. Lancaster, Ohio								
255. Laredo, Tex.	57					10,200	100	
256. Las Cruces, N.M. <sup>7/88</sup>		4,837	342	†		5,179	*100	
257. Las Vegas, Nev. <sup>7/88</sup>	45					13,025	*0	
258. Latrobe, Pa. <sup>4/88</sup>		5,008	402	20	47	5,477	*2	9
259. Lawrence, Kan.						6,501	100	
260. Leavenworth, Kan.						6,900	100	
261. Lebanon, Pa.	22					10,882	\$26	
262. Lewiston, Idaho <sup>7/88</sup>						3,981	100	
263. Lewistown, Pa.	15	7,079	377	36	15	7,507	100	100
264. Lima, Ohio		15,310	108	98		15,516	100	
265. Lincoln, Neb. <sup>9/84</sup>		27,810	2,515		259	30,584	100	100
266. Lincoln Park, Mich. <sup>7/88</sup>		13,086	390	10	24	13,510	100	0
267. Little Rock, Ark.	135	29,239	3,867	69	216	33,391	100	100
268. Logansport, Ind.	18				324	6,640	100	0
269. Long Beach, Calif. <sup>7/88</sup>	240					65,811	100	
270. Long Island, N.Y.*	157	50,648	2,846	27	34	53,555	100	0
271. Longview, Wash.	20	6,693	602	†	13	7,398	100	77
272. Lorain, Ohio	51	14,140	350	56	52	14,598	100	100
273. Los Angeles, Calif. <sup>7/88</sup>		448,800	63,933	142	10,054	522,929	100	100
274. Louisville, Ky.	366	92,069	9,357	542	516	102,484	100	100
275. Lynchburg, Va. <sup>7/88</sup>		11,870	828	296	48	13,042	100	100
276. Madison, Wis.	75	20,543	2,221	102	154	23,020	100	100
277. Manchester, Conn.	30					5,932	100	
278. Manchester, N.H.	70	†	16,443	57		16,500	100	
279. Manhattan, Kan.								
280. Manhattan B., Calif. <sup>7/88*</sup>		9,256	142	6	52	9,456	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Reed. Billing Period <sup>11</sup>	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
241	Q	1.25	P-10	625	2.00	18.67	180.67	1,800.67	none	none	none
242	Q	0.90	D-10	200	3.75	21.05	125.43	1,097.43	20.69		3.00
243	M	3.00	P-10	400	7.50				25.00		0.33
244	Q	0.75	P-5	100	3.00	30.00	300.00				none
245	M	1.25	N	300	2.15	12.15	92.15	829.90	37.44		0.00
246	M	1.25	P-10	500	2.70	27.00	136.50	1,036.50	15.00	*100.00	0.00
247	Q	1.17	P-\$0.50	167	2.42	13.42	108.92	1,011.92			0.00
248	SA	0.53	P-10	267	1.26	9.17	68.93	548.09			none
249	M	1.00	N	333	3.00	20.50	123.00	1,135.50			0.00
250	M	1.50	N	800	1.77	14.12	109.12	928.12	27.00		none
251	M	1.05	N	535	1.86	15.92	110.31	1,045.87	45.00		
252	Q	0.47		333	1.40	14.00	140.00	1,400.00			none
253	B	1.50	P-5	450	3.10	14.40	95.40	905.40	none	none	none
254		1.00		400	2.50	25.00	205.00	2,005.00			
255	M	2.00	N	1,067	2.00	16.55	117.80	1,130.30			0.09
256	M	2.10	D-10	400	3.36	22.26	211.26	2,101.26			
257	M		N		3.18	19.40	144.65	1,292.15	none	none	
258	Q	2.75	P-5		4.13	36.25	188.00	1,408.00	40.00		
259	M	1.50	P-10	267	4.53	36.15	178.40	1,393.40			
260	M	1.25	N	200	3.57	24.77	180.19	1,072.03	none	none	0.05
261	Q	1.30	P-5	267	3.50	19.50	142.00	974.50	25.00		none
262		1.25	P-\$0.50	300	6.50	37.25	296.95	2,381.96	none	none	none
263	Q	0.50	P-10		2.60	13.25	58.60	581.94	44.00		1.00
264	Q	1.00		167	2.35	13.95	121.95	1,118.67			
265	M, Q	1.00	N	550	1.68	9.60	83.85	826.35	none	none	none
266	Q	0.78	P-5	333	2.10	18.05	153.20				none
267	M	1.28	P-10	400	3.20	29.32	227.96	1,238.93	23.33		0.03
268	M	1.50	P-10	400	3.30	26.15	162.65	987.65	50.00		
269	M, B	0.60	N	0	2.50	18.90	126.50	896.50	none	none	0.10
270	Q	1.68	N	400	3.71	26.45	215.45	2,105.45	55.00		0.02
271	M	1.24	N	400	3.10	21.75	128.68	1,028.68			1.00
272	Q	1.28	P-5	667	1.70	13.47	106.13	1,003.47	none	none	0.01
273	B	0.48	N	0	2.08	15.14	122.77	986.21	36.00		0.06
274	B	0.87	D-20	133	2.26	18.46	127.66	595.66	36.00		0.11
275	M	2.80	P-\$1.00	600	4.85	44.50	200.28				0.22
276	SA	0.33	P-10	0	1.33	9.75	79.75	575.58	12.00		none
277	Q	0.63	P-6	211	3.00	10.00	58.00	580.00			none
278	Q	1.00	P-\$0.20	89	1.50	15.00	146.00	844.00	*50.00		none
279	M	1.10		40	2.75	25.00	193.75	1,678.75			
280	B	1.60	N	200	2.66	12.56	111.56	1,098.90	6.00		

<sup>11</sup> Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
281. Manitowoc, Wis.		6,559	644	125	1	7,329	100	100
282. Marinette, Wis.		3,519	283	42	1	3,845	79	0
283. Marshalltown, Iowa		5,506	400	50	10	5,966	100	100
284. Mason City, Iowa						8,644	100	
285. Massillon, Ohio		9,884	773	43	25	10,725	100	100
286. McKinney, Tex. <sup>9/55</sup>		3,100	552	71	20	3,743	100	25
287. Meadville, Pa.		4,983	444	46	12	5,485	100	100
288. Medford, Ore. <sup>7/55</sup>	25	5,576	1,139	13	19	6,747	16	5
289. Memphis, Tenn.		86,181	20,955		957	108,093	100	100
290. Menasha, Wis.		3,246	188	36	1	3,471	100	100
291. Meriden, Conn.						10,424	\$99	
292. Merrick, N.Y.*	71	†	26,432	3	44	26,479	100	68
293. Mesa, Ariz. <sup>7/55</sup>								
294. M.W.D. So. Calif. <sup>7/55*</sup>						*115		
295. Miami, Fla. <sup>7/55</sup>	375	76,959	3,691		325	80,970	100	100
296. Michigan City, Ind.	33	†	7,826	110		7,936	100	
297. Middletown, Conn.	19					4,896	100	
298. Midland, Mich. <sup>7/55</sup>	20							
299. Milford, Mass.	11	3,000	100	25	25	3,150	100	100
300. Milwaukee, Wis.	480	116,223	12,032	2,449	1,999	132,703	100	63
301. Minneapolis, Minn.	375					115,226	100	
302. Mishawaka, Ind.		8,011	701	273	37	9,022	100	100
303. Missoula, Mont.		9,184		124	56	9,364	0	100
304. Mobile, Ala.						35,840	100	0
305. Modesto, Calif. <sup>7/55</sup>	13	6,740	2,600	35		9,375	0	
306. Monroe, Mich. <sup>7/55</sup>	18	6,275	545	29	84	6,933	100	100
307. Monroe, N.C. <sup>7/55</sup>		3,339	506	109	30	3,984	100	100
308. Monterey Park, Calif. <sup>7/55</sup>	20	10,087	317	16	10	10,430	100	100
309. Moorhead, Minn.	9	3,840	266			4,026	98	
310. Mount Vernon, N.Y.	26	9,202	476	272	50	10,000	100	100
311. Murfreesboro, Tenn.		3,863	250	25		4,138	100	
312. Nacogdoches, Tex. <sup>4/55</sup>	16	3,260	350	32	70	3,712	100	100
313. Nashua, N.H.	29					6,990	\$62	100
314. Nashville, Tenn.		40,990	10,536	634		52,160	100	
315. Natick, Mass.	14				30	7,351	100	100
316. Naugatuck, Conn.	18	3,852	180	20	13	4,065	99	100
317. Neenah, Wis.		4,049	272	48	26	4,395	100	100
318. New Albany, Ind.		8,977	1,361	56	70	10,464	100	100
319. New Bedford, Mass.	85	18,547	616	25	50	19,238	100	100
320. New Haven, Conn.		†	59,149	435	413	59,997	\$74	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
281	M	0.35	P-5	200	1.47	9.07	50.57	410.57	12.00	26.40	none
282	Q	1.15	P-10		2.77	17.62	110.52				1.00
283	Q	1.00	P-10	167	4.40	24.40	139.40	1,046.67			0.10
284	Q	1.00	P-10	267	3.50	18.00	117.00	1,017.00	none	none	0.05
285	M	2.10	P-5	200	5.70	41.20	203.20				
286	M	0.75	N	133	5.15	42.50	121.50	797.50	none	none	1.00
287	Q	0.55	P-5	267	1.92	13.40	40.00	400.00			none
288	M, B	1.65	N	667	1.92	7.75	59.95	461.95			0.25
289	M	1.20	P-10	400	3.00	23.70	152.70	1,412.70			0.30
290	M	1.00	N	533	2.05	18.10	97.30	607.05			
291	SA	0.75	P-5	525	4.50	14.25	76.50	907.88			
292	M, B	2.05	N	400	3.99	24.86	180.11		*		0.00
293											
294	M	0.00	N	0							none
295	Q	1.25	N	600	2.05	19.00	120.90	1,020.90	30.00		0.25
296	M	1.38	P-10	1,000	1.38	11.28	81.48	621.48	60.00		0.01
297	SA	1.00	N	1,000	1.00	4.75	35.55	160.55	none	none	none
298	Q	1.13	P-\$0.50	178	3.85	20.00	155.00	1,505.00	50.00		none
299	Q	1.37	N	250	4.50	31.50	193.50	1,813.50	50.00		
300	Q	0.25	P-5	0	0.93	7.50	73.33	620.83			none
301	Q	1.00	P-10	500	2.00	20.00	200.00	2,000.00	none	none	0.01
302	Q	0.75	N	500	1.50	9.93	72.93	702.93			0.10
303	M	0.85	¶	¶	1.50	15.00	84.00	407.00			
304	M	2.40	N	533	*4.50	*41.25	*266.25	*1,511.25			0.25
305		2.25	D-5	¶	0.68	6.30	55.65	258.15			none
306	B	1.43	D-5	400	2.71	20.38	145.78	1,171.78			0.04
307	M	1.00		200	3.40	22.65					0.15
308	B	1.50	N	800	1.80	16.70	151.85				
309	M	1.00	P-5	250	2.10	12.80	87.30	762.30	40.00		0.46
310	Q	0.67	P-10	333	2.00	20.00	161.67	1,511.67	none	none	none
311	M	1.75	P-10	437	3.25	19.95	153.95	1,288.95	50.00		0.10
312	M	1.25	N	333	3.44	14.88	116.13	1,128.63	none	none	0.20
313	Q	1.92	N	890	1.92	17.00	111.67	746.16	20.00	47.52	0.80
314	Q	0.90	*P	0	2.40	19.15	143.40	1,023.40	48.00	none	0.08
315	Q	0.50	P-\$0.20	200	2.50	19.00	111.50	741.50	none	none	none
316	Q	1.25	N	307	3.28	17.53	118.78	1,131.28	10.00	38.55	0.00
317	Q	1.00	P-10	267	2.67	20.95	141.57	844.57			
318	M	2.75	P-10	560	4.68	36.20	184.70	957.20	75.00		0.25
319	Q	0.50	P-\$0.50	333	1.50	13.33	109.17	552.50	none	none	none
320	Q	1.60	N	333	3.27	25.77	172.43	922.43	14.40	27.94	0.05

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

¶ No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Em- ployees	Customers					Resid. Svc. Metered %†	Public Svc. Metered %‡
		Resid.	Coml.	Ind.	Public	Total		
321. New Iberia, La.*		18,262	2,187		160	20,609	100	100
322. New Orleans, La.								
323. New Rochelle, N.Y.	71	21,774	1,132	62	94	23,062	100	100
324. New York, N.Y.						758,375	\$25	
325. Newport Beach, Calif. <sup>7/55</sup>	18					8,961	100	0
326. Newport News, Va.*		36,062	871			36,933	100	
327. Newton, Iowa		4,350	65	15	15	4,445	99	100
328. Newton, Kan.		4,385	280	29	18	4,712	100	11
329. Niagara Falls, N.Y.	102	20,348	150	245		20,743	100	
330. Niles, Ohio						5,788	100	
331. Norfolk, Neb.	7	3,500	400	50	65	4,015	100	77
332. Norfolk, Va.	215	56,537	3,652	†		60,189	97	
333. North Miami, Fla.						9,616	100	
334. North Platte, Neb.	18					4,571	100	
335. Norwich, Conn.		†	6,856	79	7	6,942	95	100
336. Oak Park, Ill.		13,500	650			14,150	100	
337. Oak Ridge, Tenn.						7,541	100	
338. Ocala, Fla. <sup>10/55</sup>	19					4,429	100	
339. Oceanside, Calif. <sup>7/54</sup>						4,741		
340. Oklahoma City, Okla. <sup>7/55</sup>	289						100	
341. Olean, N.Y. <sup>6/55</sup>	29	6,700		42	8	6,750	100	100
342. Omaha, Neb.		71,264	664	6	2	71,936	100	100
343. Oneonta, N.Y.	16	3,680		25	15	3,720	63	0
344. Ontario, Calif.						11,802	100	
345. Orange, Calif. <sup>7/55</sup>	25					5,235	100	
346. Orlando, Fla.	85					29,875	100	
347. Oskaloosa, Iowa	12	3,895	150	15		4,060	100	
348. Ossining, N.Y.	15					3,500	100	
349. Ottawa, Kan.		2,889	636			3,525	100	
350. Ottumwa, Iowa	35	9,028	403	131		9,562	100	
351. Owatonna, Minn. <sup>3/55</sup>	9	2,961	321	†	12	3,294	100	100
352. Oxnard, Calif. <sup>5/55</sup>						6,500	\$49	
353. Painesville, Ohio		4,327	513	30		4,870	100	
354. Palo Alto, Calif. <sup>7/55</sup>						16,244	100	
355. Paris, Tex. <sup>7/55</sup>					50	7,300	100	0
356. Pasadena, Calif. <sup>7/55</sup>	125				175	39,367	100	100
357. Pasco, Wash.	18	2,800	556	15	12	3,383	100	100
358. Passaic Val. Com., N.J.*	275					45,534	\$99	
359. Peekskill, N.Y.	31				15	3,709	100	100
360. Pendleton, Ore. <sup>7/55</sup>		3,400	200			3,600	100	

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period	Min. Charge per Month	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
321	M	1.25	N	400	2.60	18.60	93.60	768.60			
322	Q	0.60		0	2.28	6.60	140.00	1,244.00			
323	Q	1.26	N	400	3.15	31.50	210.74	1,830.74	69.00	69.00	0.10
324					1.50	15.00	150.00	1,500.00			
325		2.55	N	700	2.91	14.91	123.87		none	none	0.30
326	Q	1.83	N	600	5.20	28.67	164.17	1,289.17			
327	M	1.10		200	3.75	23.62	137.62	1,007.62	75.00		0.02
328	Q	1.20	N	300	2.95	22.86	134.73				0.40
329	Q	1.03	P-10	100	1.65	16.50	127.00	714.00	none	none	0.00
330	Q	1.00	N	333	3.00	15.50	105.50	691.60	none	none	0.01
331	Q	0.75	N	500	*3.75	*26.15	*135.16	*552.00			
332	Q	1.60	N	400	2.25	22.50	147.00	1,362.00	100.00		none
333	M	1.70	D-5	667	2.55	22.86	225.36				0.50
334	M	0.75	N	667	1.05	9.40	66.75	476.75			
335	Q	1.00	P-5	167	1.47	7.32	53.65	370.32	30.00	66.00	none
336	Q	1.08	D-10	400	2.70	27.00	244.00	2,074.00			
337	M	1.20	P-10	333	3.07	22.55	151.55				
338	M	1.50	P	500	2.85	24.35	171.35	1,611.35	50.00		0.50
339	M	2.50	P-10	1,000	2.50	7.90	61.90	601.90			
340	B	1.50	P, D		3.80	22.35	151.85	1,076.85			0.10
341	Q	1.17	P-10	333	2.97	21.27	138.27	1,058.27			
342	M	1.25	N	500	2.10	14.90	115.40	925.40			none
343	A	1.67	P-5	445	3.75	34.00	202.00		40.00		0.03
344	B	1.50	P	700	1.86	11.16	94.32	724.32			none
345	B	2.25	P	1,000	2.25	21.30	183.30	1,803.30	none	none	0.20
346	M	1.00		433	1.75	14.25	92.80	756.00	25.00		0.06
347	Q	0.92	D-10	200	4.50	25.05	142.80	1,267.80			0.00
348	Q	1.33	P-5	333	3.92	33.08	267.08		none	none	0.10
349	M	1.00	P-10	160	3.23	19.43	132.83	1,212.83	*		0.10
350	Q	1.50	P-5	400	3.60	26.40	154.40	1,209.40	none	none	0.30
351	Q	1.00	P-10	333	2.67	11.17	74.17	749.17	15.00		0.03
352	B	1.50	P	500	3.00	18.30	141.30	1,059.32	10.00		0.00
353	M	1.00	N	400	2.40	19.20	141.60				none
354	M	1.35	N	500	2.70	24.10	211.10	2,011.10	18.00		0.06
355	M	1.00	D-10	200	2.68	14.68	143.02	809.02			0.10
356	B	1.50	N	500	2.25	15.85	135.00	1,041.80			0.12
357	M	2.00	P-\$2.00	500	3.00	8.00	64.00	528.00	12.00		none
358	Q	0.75	N	0	2.25	16.40	138.32	939.80	10.00	35.90	none
359	Q	0.33	P-1	200	1.60	15.00	117.35	1,107.35	none	none	none
360	M	1.10	P-\$1.00	467	1.70	11.80	93.55	903.55			1.00

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

TABLE 3 (contd.)

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
361. Phenix City, Ala.								
362. Philadelphia, Pa.						513,000	\$84	
363. Phila. Sub. Wtr. Co., Pa.*		148,755	4,095	3,084	982	156,916	*100	42
364. Phoenix, Ariz. 7/66						59,037	100	
365. Pittsburg, Calif. 7/65	9	3,957	795	20	16	4,788	100	100
366. Pittsburg, Kan.	30						100	
367. Pittsburgh, Pa.	553	111,813	7,611	2,219	4	121,647	*82	100
368. Pomona, Calif. 7/66		14,249	950	475	158	15,832	100	100
369. Pontiac, Mich.		18,275	703	†		18,978	96	
370. Poplar Bluff, Mo.	20	4,279	486		50	4,815	100	100
371. Portland, Me.	159					30,362	\$53	
372. Portland, Ore. 7/66	440	102,334	9,959	838	384	113,516	*100	100
373. Portsmouth, Va. 7/66		29,100	1,200	150	50	30,400	100	100
374. Prichard, Ala.		†	12,104	30	2	12,136	\$84	100
375. Providence, R.I. 10/64	175	53,334	2,535	1,329		57,198	*100	
376. Puerto Rico A.S.A. 7/66*		165,192	19,636	1,230	2,933	188,991	*80	0
377. Queens County, N.Y.*	30	†	19,208	57	95	19,360	\$7	47
378. Racine, Wis.	53	18,289	1,464	367	118	20,238	100	100
379. Rahway, N.J.						6,610	100	
380. Reno, Nev.	40	13,612	1,843	†		15,455	\$0	
381. Richmond, Va. 7/66						58,341	100	
382. Ridgewood, N.J.	30	14,000	380	22	16	14,418	100	100
383. Roanoke, Va.	140	23,296	1,800	420	100	25,616	100	100
384. Robbinsdale, Minn.	4	†	3,800			3,800	100	
385. Rochester, N.H.	15							
386. Rochester, N.Y.*	55	†	25,185	130	124	25,439	100	72
387. Rome, N.Y.	26	7,950	547	28	25	8,550	*0	0
388. Sacramento, Calif.	150	46,449	398	†		46,847	0	
389. St. Charles, Mo. 4/66								
390. St. Cloud, Minn.	20	5,767		12		5,779	99	
391. St. Louis, Mo. 4/64	830	141,581	584	†	335	142,500	10	100
392. St. Louis County, Mo.	385	114,327	5,238	41	71	119,677	100	100
393. St. Louis Park, Minn.	20					9,550	100	
394. St. Paul, Minn.	300	70,530	2,240			72,770	100	
395. Salem, Ohio	12	†	4,313	55		4,368	100	
396. Salem, Ore. 7/66		11,168	1,820	102	35	14,125	100	100
397. Salina, Kan.	35							
398. Salisbury, Md.	19	4,700	675	†	5	5,380	5	0
399. Salt Lake City, Utah	170	48,911	2,404	246	327	51,888	100	100
400. San Angelo, Tex. 10/64	46	14,417	1,500	100	120	16,137	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>1)</sup>	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
361		2.25	N	667	3.13	24.25	171.75	1,391.75			0.25
362	A	0.88	P-10	333	1.34	8.48	92.54		20.00		5.00
363	Q	0.00			4.98	39.85	232.03				0.13
364	M	2.00	N	1,000	2.00	*14.60	*136.60	*830.03	none	none	0.20
365	B	1.65		700	2.35	21.80	190.00	1,900.00			0.50
366	M	1.25	P-10	267	3.42	23.92	193.92	1,881.42	8.50	none	2.00
367	Q	0.28	P, D	0	2.55	25.50	202.50	1,890.00	none	none	
368	B	1.63		600	2.30	17.67	135.02	766.52			0.02
369	Q	1.10	N	500	3.30	8.96	85.32	663.00			
370	M	0.77	N	267	2.40	12.61	93.61	903.61			0.38
371	Q	1.12	N	400	2.54	19.34	99.34	819.34			0.00
372	Q	0.85	N	600	1.41	13.29	108.10	668.00	none	none	none
373	Q	0.90		400	1.92	19.23	164.25	1,406.25	*	none	
374	M	1.50	P-\$0.25	533	2.81	22.38					4.00
375	A	0.67	N	370	1.80	13.98	91.97	766.97			
376	B	1.05		350	2.91	24.50	173.98	1,131.58	none	none	0.01
377	M, Q	0.90	N	400	2.25	10.01	84.26		45.00		0.00
378	Q	0.83	P-10	333	2.03	16.06	107.60	684.06			none
379	Q	1.50	P	533	2.76	9.00	75.00	559.53			
380	M	3.15	N	¶					24.00		0.10
381	M	1.50	N	600	2.26	19.36	101.36	821.36	92.15		0.30
382	Q	0.50	D-3	0	2.75	23.33	144.00		40.00		0.10
383	Q	1.25	N	200	3.81	27.01	187.01	935.01	45.00		1.00
384	Q	1.50	P-5	1,000	1.50	15.00	150.00	1,500.00			none
385	SA	0.83	P-6	390	2.17	18.73	60.00	375.00	60.00		none
386	M, Q	1.35	D-\$0.10	400	2.47	18.74	172.34	1,387.34	*		0.00
387	SA	0.50	P-5	400	2.30	12.50	61.83	466.83			
388	Q	0.70	N	¶	1.50	12.00	90.00	630.00			
389		1.22	P-5								
390	Q	0.50	P-10	167	3.00	23.50	120.00	900.00	50.00		2.00
391	SA	0.16		117	1.45	10.65	80.65	693.98			0.00
392	Q	1.20	N	400	2.40	18.73	132.00	1,077.00	36.00		0.12
393	Q	0.63	P, D	317	2.00	20.00	200.00	2,000.00			2.00
394	Q	0.25	P	0	1.75	15.60	125.00	815.00	5.00		none
395	Q	1.33	D-10	167	1.88	11.99	66.59	384.59	none	none	none
396	M	1.20	N	360	2.30	13.40	67.60	517.60	none	none	none
397	M	1.75	P-10	700	2.50	21.10	164.10	1,604.10			0.26
398	Q	1.00	N	¶	2.13	19.00	196.96	871.20	none	none	none
399		1.00	N	48	1.80	18.00	120.00	1,200.00			none
400		1.50	N	267	3.40	21.25	152.08	1,520.80			0.50

¶ Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

¶ No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
401. San Antonio, Tex.	415	104,461	2,265	†		106,726	100	
402. San Bernardino, Calif. <sup>7/88</sup>	97	25,938			72	26,010	100	100
403. San Francisco, Calif. <sup>7/88</sup>		123,946	31,421	†	691	156,058	100	100
404. Sandusky, Ohio		†	8,330	48	27	8,403	100	100
405. Sanford, Fla. <sup>10/88</sup>		3,810	570	4	13	4,397	100	100
406. Sanford, N.C. <sup>7/88</sup>	10				50	3,600	100	0
407. Santa Barbara, Calif. <sup>7/88</sup>	69	†	15,348	20	300	15,668	100	0
408. Santa Cruz, Calif. <sup>7/88</sup>	40	11,516	90	*162		11,768	100	
409. Santa Fe, N.M.	27	5,424	1,438		2	6,864	100	100
410. Santa Paula, Calif.	16	†	3,598	*58	11	3,667	100	100
411. Santa Rosa, Calif. <sup>7/88</sup>						10,843	\$99	
412. Schenectady, N.Y.				1,169	9			100
413. Scottsbluff, Neb.		3,265	504	†	50	3,819	100	0
414. Scranton, Pa.*		119,150	8,385	730	998	129,263	*35	41
415. Seattle, Wash.	368	141,535	6,002	†	483	148,020	100	100
416. Shamokin, Pa.*	45	11,453	566	108	12	12,139	100	100
417. Sharon, Pa.*		13,493	1,133	34	4	14,664	100	0
418. Shawnee, Okla. <sup>7/88</sup>	37					8,250	100	
419. Sheboygan, Wis.	38	10,357	1,032	142	157	11,688	100	83
420. Sheffield, Ala. <sup>8/88</sup>		3,374	424	43	10	3,851	100	100
421. Shelbyville, Ind.		3,465	506	48	24	4,043	100	100
422. Sheridan, Wyo.	8	3,200	*815	†		4,015	100	
423. Shorewood, Wis.	5						100	
424. Shreveport, La.	262	31,814	3,936	246	2	35,998	100	100
425. Sioux City, Iowa	62	22,800	1,000	†		23,800	100	
426. Sioux Falls, S.D.		14,000	1,000	†		15,000	100	
427. Snyder, Tex. <sup>10/88</sup>	10							
428. South Gate, Calif. <sup>7/88</sup>	21	9,954	1,327	1,991	35	13,307	100	0
429. South Milwaukee, Wis.		3,373	222	34	42	3,671	100	100
430. South Orange, N.J.	12					3,975	100	
431. South St. Paul, Minn. <sup>4/88</sup>		4,240	78	8	20	4,356	100	100
432. So. Calif. Water Co.*	300	†	92,746	974	337	94,057	\$91	99
433. Spokane, Wash.	125	44,989	6,471	†	250	51,710	100	100
434. Springfield, Ill. <sup>3/88</sup>	150	†	29,094	60		29,154	100	
435. Springfield, Mass.		†	35,392		349	35,741	\$99	70
436. Springfield, Mo.	96	23,711	1,500	110		25,321	100	
437. Stamford, Conn.	47					14,660	100	
438. Sterling, Ill.	22	5,646	296	37	21	6,000	100	91
439. Stevens Point, Wis.		3,820	425	27	49	4,321	100	100
440. Struthers, Ohio		5,036	226	4	40	5,306	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>1</sup>	Min. Charge per Month \$	Penalty or Discount <sup>2</sup>	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
401	B	1.00	D-10	500	1.57	13.86	76.14	517.27	none	none	0.35
402	M	1.75			1.75	13.00	106.00	731.00			0.00
403	B	0.70	N	0	3.29	25.36	205.36	1,559.89	36.00		0.06
404	Q	1.38	D-10	870	1.60	13.15	104.20	1,004.20	none	none	
405	M	2.27	N	533	3.50	22.62	118.87	931.37	none	none	
406		1.62	D-10	300	3.37	17.28	138.60	1,261.22			<1
407	B	1.60	N		2.10	21.00	175.00	1,615.00	none	none	0.01
408	B	1.25		500	2.00	12.10	75.10	705.10			0.20
409	M	2.00	N	267	5.44	24.00	184.38	1,534.38	22.50		0.50
410	M	1.25	N	500	2.00	14.00	104.00		*		0.10
411	B	1.55	N	667	2.48	20.55	150.30	1,432.80			none
412		0.71	P		0.80	8.00	80.00	730.00			none
413	M	1.25	N	667	1.85	9.00	63.25	603.25	none	none	
414	Q	1.00	P-5	667	3.73	16.95	117.62	1,135.28	*		none
415	Q	0.50	N	300	1.70	17.70	170.70	1,700.70			none
416	Q	1.50	D-5	133	*6.98	*28.72	*160.35	*1,476.60			0.07
417	Q	0.99	D-5	100	4.66	35.30	245.81	1,673.14	10.00	*270.00	0.25
418	M	1.50	N	133	5.88	40.15	238.80				0.00
419	Q	0.45	P-5	200	1.49	11.34	79.67	477.51	11.00	*580.80	none
420	M	1.50	P-10	400	3.15	25.20	189.70	806.70			0.24
421	M	1.85	P-10	560	3.05	21.75	118.25	868.25			0.21
422	M	1.25	N	700	1.47	6.59	43.59	323.59	none	none	
423	Q	0.00	P-5	0	1.70	15.25	150.83				none
424	M	1.50	N	382	2.63	25.00	144.75	1,089.75	40.00		0.00
425	M	1.45	P-\$1.50	400	3.47	15.94	112.80	1,081.43	30.00		0.30
426	Q	0.75	N	267	2.70	16.93	107.70	907.70			
427	M	3.00	N	400	4.85	28.19	250.82		none	none	0.03
428		1.30			1.30	10.20	76.60	766.00			1.50
429	*	0.50	P-5	300	1.61	10.79	78.59	625.16			0.00
430	SA	0.75	P-6	160	3.40	31.92	316.00				
431	Q	0.50		312	1.65	16.00	93.15	505.65			0.28
432	M, B	1.80	N	700	2.37	18.77	151.42	1,106.42	24.00		0.26
433	*	0.75		833	0.93	9.01	89.96	724.46	none	none	
434		1.00	P-10	600	1.75	13.50	103.50	1,003.50			0.00
435	Q	0.73	N	333	2.20	14.50	83.50	713.50			none
436	Q	1.95	N	400	4.41	41.31	212.91	1,382.91	60.00		0.00
437	Q	1.10	N	300	3.34	31.34	149.94	899.64		36.43	0.08
438	M	1.50	P-5	300	4.44	33.66	228.16	1,458.19	42.50		0.11
439	Q	1.00	P-5	333	1.96	13.90	85.40	640.40			none
440	Q	1.22	N	333	3.27	27.10	215.40	1,968.54	35.00		

|| Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

# Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
441. Superior, Wis.		8,183	718	131	1	9,033	*100	0
442. Swampscott, Mass.	10	3,600			36	3,636	100	100
443. Syracuse, N.Y.							100	0
444. Tacoma, Wash.								
445. Tampa, Fla. <sup>10/66</sup>	213					58,714	100	
446. Taunton, Mass.	40	7,373	130	110	68	7,681	100	100
447. Terrell, Tex. <sup>4/66</sup>		3,050	45	10		3,105	98	
448. Texarkana, Tex.		11,578	1,264	42	84	12,968	100	100
449. Texas City, Tex. <sup>7/66</sup>						6,693	100	
450. Toledo, Ohio	325	†	94,574	790	1,200	96,564	100	0
451. Tonawanda, N.Y.		4,744	11	56	8	4,819	75	100
452. Topeka, Kan.						32,665	100	
453. Torrance, Calif. <sup>7/66</sup>	30	†	13,857	157	47	14,061	100	100
454. Torrington, Conn.	14	4,444	128	52	24	4,648	100	87
455. Tucson, Ariz. <sup>8/66</sup>					50	22,448	100	100
456. Tulare, Calif. <sup>7/66</sup>	9	3,895	383	3	12	4,293	*2	0
457. Tulsa, Okla. <sup>7/66</sup>	500					76,032	100	
458. Two Rivers, Wis.		3,011	239	31	42	3,323	87	0
459. Uniontown, Pa.		5,077	210	30	70	5,387	98	100
460. Vancouver, Wash.		12,754	1,047			13,801	91	
461. Ventura, Calif. <sup>7/66</sup>	35	7,426	763	41	17	8,447	100	100
462. Vernon, Tex. <sup>4/66</sup>						3,987	100	
463. Vincennes, Ind.		†	5,643	48	45	5,736	100	100
464. Virginia, Minn. <sup>4/66</sup>	18	3,683	400			4,083	100	
465. Walla Walla, Wash.						7,637	100	
466. Wallingford, Conn.	15	4,411	300	68	6	4,785	99	100
467. Washington, D.C. <sup>7/66</sup>	748	113,645	15,148	761	547	130,101	96	100
468. Washington, Ind.	11	3,950	50	4	6	4,010	100	83
469. Washington C. H., Ohio*		3,316	310	36	24	3,686	100	100
470. Waterloo, Iowa	32					16,724	100	
471. Watertown, N.Y. <sup>7/66</sup>	38	7,244		171		7,415	100	
472. Watertown, S.D.						2,859	100	
473. Waterville, Me.	20	5,458	530	55	110	6,153	*85	77
474. Waukegan, Ill. <sup>8/66</sup>	31	11,459	197	†	24	11,680	100	100
475. Wauwatosa, Wis.		9,690	255	28	37	10,010	100	100
476. Waycross, Ga.						4,934	§96	
477. Webster, Mass.		2,412	4	8	9	2,433	98	67
478. West Allis, Wis.	22	11,038	798	106		11,942	100	
479. W. University Pl., Tex.*		5,210	140	†		5,350	100	
480. West View, Pa.	55	21,884	745	50	49	22,728	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
441	M	0.85	N	0	3.05	14.30	114.10	887.10			
442	Q, A	1.00	N	333	2.33	17.42	152.42	1,502.42			
443	Q	0.75	P-5	417	1.80	18.00	113.33	1,103.33			none
444	B	1.00		267	1.30	10.75	69.75	519.75			0.10
445	M	1.82	D-10	667	2.18	20.29	142.07	1,255.80	20.00		<1
446	Q	0.73	N	35	2.75	19.46	123.09	1,023.09	none	none	none
447	M	1.50	D-10	267					none	none	5.00
448		1.50	P-10	333	3.70	21.80	156.80	1,506.80	37.50		0.20
449	M	1.35	N	267	3.25	20.50	156.75	1,506.75			
450	Q	0.87	N	667	1.30	13.00	126.40	1,033.60	none	none	none
451	Q	1.25	P-10	667	1.88	11.75	69.45	542.75			
452		0.35	N	100	2.96	18.26	123.26	1,113.26	35.00		
453	B	1.50	N	600	2.14	16.54	124.54	834.54	none	none	0.01
454	Q	1.57	N	133	4.04	23.12	156.12	906.12	10.00	110.88	0.50
455	M	1.77	N	700	2.07	11.16	102.06	1,011.06	24.00		none
456	M	2.50	P-20	¶	2.00	9.00	73.50	748.50	none	none	0.12
457	M	1.25	P-\$0.10	133	4.18	28.85	141.35	978.85	none	none	
458	M	1.30	P-5	300	3.40	21.80	104.80	734.80			none
459	Q	1.72	N	100	5.39	37.69	298.50	1,854.00			0.50
460	B	1.50	N	400	3.30	21.30	93.10	551.50			
461	B	1.84	N	800	2.18	17.48	125.48	1,205.48	none	none	0.10
462		1.50	N	267	3.70	20.45	155.45	1,505.45			1.60
463	M	1.50	P-10	400	3.00	22.80	167.80	887.80	12.00	13.20	0.10
464	M	1.50	P-10	500	2.60	26.00	174.00	1,614.00	40.00		0.40
465	M	1.00	N	667	1.50	12.25	81.25	534.00			none
466	SA	1.25	P	445	2.75	18.00	150.00	1,095.00	35.00		none
467	SA	1.00	P-10	600	1.44	11.34	110.34	1,100.34	none	none	none
468	M	2.00	P-10	500	4.00	35.50	190.50	730.50	85.00		3.00
469	M	1.65	N	200	4.77	30.83	260.06	2,552.59			
470		0.75	P-10	300	2.18	14.35	74.34	614.34	none	none	0.00
471	Q	1.13	P-10	300	2.85	18.08	113.06	923.06	none	none	none
472	M	1.00	P-5	400	2.50	20.48	90.88	720.88			none
473	Q	1.00	N	667	1.50	15.00	50.00	345.00	30.00		none
474	Q	0.90	D	400	1.97	17.12	107.70	760.40	4.00		0.00
475	Q	0.25	P-10	0	1.35	13.50	135.00	1,350.00			none
476	M	1.25	N	400	2.75	20.05	130.45		none	none	
477	Q, SA	0.58	N	292	2.00	19.33	155.33		none	none	
478	Q	0.75	P-5	0	1.90	13.50	127.75	1,137.75			none
479	M	1.50	P-10	535	2.38	16.00	151.00	1,501.00	none	none	0.00
480	Q	1.42	D-\$0.25	311	4.00	34.75	182.60	1,581.89	35.00		0.00

¶ Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

\* Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

¶ No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8	9
Community*	No. of Employees	Customers					Resid. Svcs. Metered %†	Public Svcs. Metered %
		Resid.	Coml.	Ind.	Public	Total		
481. Westchester Co., N.Y.*	48					8,500	100	100
482. Westerly, R.I.						5,636	100	
483. Westmoreland Co., Pa. <sup>4/88</sup>		32,431	3,726	207	190	36,554	100	100
484. Weymouth, Mass.	40	11,059	89			11,148	100	
485. Whittier, Calif. <sup>7/88</sup>		9,833				9,833	100	
486. Wichita, Kan.*	174	52,210	9,080	278	260	61,828	*100	97
487. Wilkesburg-Penn. Pa.	149	35,424	649	51	103	36,227	100	100
488. Williamsport, Pa. <sup>7/88</sup>		14,745	1,079	127	74	16,025	100	100
489. Wilmington, N.C. <sup>7/88</sup>	70							
490. Wilson, N.C. <sup>7/88</sup>		6,500	735	8	25	7,268	100	100
491. Winnetka, Ill. <sup>4/88</sup>	5	3,457	166	0	5	3,628	100	100
492. Wisconsin Rapids, Wis.	41	3,270	354	33		3,657	100	
493. Worcester, Mass.						33,767	100	
494. Wyandotte, Mich. <sup>10/88</sup>		10,332	1,010	250	30	11,622	100	100
495. Yonkers, N.Y.							100	
496. York, Pa.	78	25,492	1,363	608	144	27,607	*18	100
497. Youngstown, Ohio		†	46,336	194	50	46,580	100	100

\* See notes beginning on p. 694.

† Included in "Coml."

‡ Figure given is percentage of total residential services; unless otherwise noted, commercial and industrial services are 100 per cent metered.

§ Includes commercial and industrial.

1	10	11	12	13	14	15	16	17	18	19	20
	Resid. Billing Period <sup>1</sup>	Min. Charge per Month \$	Penalty or Discount #	Allow- ance on Min. cu ft	Monthly Rates@—\$/cu ft				Public Fire Svc. Charge		Billing Written Off %
					1,000	10,000	100,000	1,000,000	\$/hyd.	\$/in.-mi.	
481	Q	1.33	P-2	333	3.53	30.17	201.33	1,648.92	65.00		none
482		1.15	N		3.00	23.25	157.50		25.00		none
483	Q	*		*	*	*	*	*	*	*	0.00
484	Q	0.67	N	208	3.50	19.59	124.35	911.55	none	none	0.02
485	M	2.00	N	1,000	2.00	20.00	115.00		none	none	
486	Q	0.67	D-10	1.33	4.48	35.82	61.12	434.57	13.72	96.57	0.36
487	M, Q	1.50	N	417	3.48	34.08				280.00	0.05
488	Q	0.97	P-10	222	3.15	15.47	107.98	785.48	60.00	*	
489	Q	1.42	N	500	2.62	22.22	144.38	1,166.05	none	none	0.07
490	M	1.20	N	500	1.20	16.29	135.11	1,323.11	15.00	none	1.00
491	B	0.85	P-\$0.25	247	2.10	21.00	210.00	2,100.00	18.50	none	
492	Q	1.50	N	333	3.50	29.00	183.67	1,133.67			
493	SA	0.67	N	333	2.00	16.50	142.50	1,402.50	none	none	0.04
494	Q	0.63	D-10	290	1.81	12.33	79.83	754.83			none
495	SA	0.73	P-8	333	2.20	22.00	204.00	1,748.00			none
496	M	1.95	D-2	280	4.23	15.34	120.64	867.09			0.04
497	Q	1.00	D-10	333	0.90	8.19	48.69	288.69			

<sup>1</sup> Key: M—monthly; B—bimonthly; Q—quarterly; SA—semiannually; A—annually.

\* Key: P—penalty; D—discount; N—net. "P-5" means 5 per cent penalty.

\* No limit; flat rate to most or all residential users.

@ Discounted rates are shown if prompt-payment discount is offered.

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
1. Aberdeen, S.D.	137.4	61.9			199.3		
2. Adrian, Mich. <sup>7/55</sup>	102.1	13.1	130.6	0.8	246.6	3.3	5.3
3. Akron, Ohio	1,516.4	144.0	800.0	11.8	2,472.2		
4. Albany, N.Y.							
5. Albemarle, N.C. <sup>7/55</sup>	108.7		20.8		129.5		
6. Albert Lea, Minn.					94.7		3.1
7. Albion, Mich.					75.9		
8. Albuquerque, N.M. <sup>7/55</sup>					2,092.8		
9. Alexandria, La. <sup>8/55</sup>					423.3		
10. Alhambra, Calif. <sup>7/55</sup>	†	489.0			489.0		
11. Allen Park, Mich.							
12. Alliance, Ohio	†	207.2	113.5		320.7		
13. Amarillo, Tex. <sup>10/55</sup>					1,629.8	‡	
14. Americus, Ga.							
15. Ames, Iowa					342.5		
16. Anaheim, Calif.							
17. Annapolis, Md. <sup>7/55</sup>					238.6		
18. Anniston, Ala. <sup>4/55</sup>	335.7	14.3	206.9	7.8	564.7	3.8	11.1
19. Ansonia, Conn.	†	133.7	71.7	0.1	205.5	3.9	19.6
20. Antioch, Calif. <sup>7/55</sup>					225.3		
21. Appleton, Wis.	166.9	52.2	72.8	3.4	295.3	19.3	77.2
22. Arcadia, Calif. <sup>7/55</sup>							
23. Arlington, Va. <sup>7/55</sup>					1,107.2		
24. Asheville, N.C. <sup>7/55</sup>					1,099.2		
25. Ashland, Ohio					167.7		
26. Athol, Mass.	71.0	20.0			91.0		
27. Atlanta, Ga.	1,833.4	2,026.4	965.0	68.4	4,893.2		
28. Atlantic City, N.J.					574.7		
29. Auburn, Me.	74.0	11.2	2.8		88.0	3.1	
30. Auburn, N.Y. <sup>7/55</sup>	159.8	150.2	†		310.0		
31. Augusta, Ga.					1,209.1		
32. Augusta, Me.	83.4	16.3	31.4	1.8	136.9	17.9	8.9
33. Austin, Minn. <sup>3/55</sup>					191.2	1.1	5.4
34. Austin, Tex. <sup>10/55</sup>					2,855.9	94.0	
35. Baltimore, Md.				9.5	9,877.4		32.6
36. Bangor, Me.	167.3	59.7	12.6	3.1	242.7	0.2	15.8
37. Barberton, Ohio	155.0	25.0	110.0		290.0		
38. Batavia, N.Y.					137.8		
39. Baton Rouge, La.							
40. Bay City, Mich. <sup>7/55</sup>	441.4	147.1	†	4.9	593.4	6.8	40.0

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.\$						\$1,000	\$/cap.\$
1		199.3	8.67	50.9	162.3	†			162.3	7.06
2	11.2	266.4	13.32	none	149.4	†			149.4	7.17
3	324.3	2,796.5	9.42	469.0	840.4	401.9	16.9	227.7	1,486.9	5.01
4		1,443.1	10.70						989.8	7.34
5		129.5	8.63	18.5	49.9	30.0			79.9	5.32
6	0.6	98.4	6.15		45.8	†			45.8	2.86
7	3.3	79.2	6.10		43.1	8.2			51.3	3.96
8	162.9	2,255.7	13.27		894.5	354.0		30.6	1,279.1	7.52
9	68.0	491.3	9.10		271.7	39.6			311.3	5.77
10		489.0	8.89	1.5	220.5	69.2	2.5	62.1	354.3	6.44
11										
12	26.2	346.9	11.19	22.7	140.7	50.1		1.0	191.8	6.19
13	58.6	1,688.4	12.98	none	353.7	88.3	2.1		444.1	3.42
14										
15		342.5	14.90	4.1	116.4	21.0		32.5	169.9	7.40
16										
17	12.0	250.6	9.29		101.5	2.5			104.0	3.85
18	0.8	580.4	11.85	none	112.8	31.7	12.9		157.4	3.22
19	19.0	248.0	13.78	none	66.9	5.2	74.3	8.6	155.0	8.61
20	8.4	233.7	16.70	none	55.9	54.3			110.2	7.88
21	13.0	404.8	10.11	none	194.5	19.6			214.0	5.35
22		479.1	13.70							
23	245.2	1,352.4	8.30		875.9	†		1.0	876.9	5.38
24		1,099.2	10.99						687.7	6.88
25		167.7	10.48		106.4	41.5			147.9	9.24
26		91.0	7.58	7.6	20.0	34.0	0.2		54.2	4.51
27	13.9	4,907.1	9.58	747.0	993.9	832.9			1,826.8	3.57
28	34.4	609.1	6.77	145.8	279.7	†	10.0		289.7	3.22
29	6.8	97.9	5.15	none	23.5	34.6			58.1	3.06
30	22.5	332.5	6.94	3.5	183.6	27.2		17.7	228.5	4.77
31		1,209.1	8.06		221.8	123.2		8.1	353.1	2.35
32	0.2	163.9	7.45	none	61.6	12.3	0.7		74.6	3.39
33	4.0	201.7	8.40						62.0	2.58
34		2,949.9	15.25	none					858.4	4.41
35	568.3	10,478.3	8.06		2,603.5	967.6		0.2	3,571.3	2.75
36	26.2	284.9	8.90	none	107.7	46.5	1.2	63.9	219.3	6.85
37		290.0	8.28	30.0	250.0	75.0			325.0	9.28
38	47.8	185.6	10.31	16.1	93.9	44.2			138.1	7.67
39										
40	8.8	649.0	10.81	none	198.7	81.5		104.4	384.6	6.41

† Included in preceding column.

‡ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depreci- ation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.§			
1		41.7				41.7	1,607	70		29	
2		71.1				71.1	1,628	81	11483	263	495
3	0.6		1,308.2	17.5		1,325.7	28,834	97	none	1,127	9,047
4											
5		132.8				132.8					
6						56.4	515	32	180		
7		6.1				6.1	284	22	150	337	
8			1,640.0			1,640.0	16,595	98	4,154	3,342	14,151
9							1,642	30	339	none	none
10	0.5	214.2				214.2	4,143	75	1,512	none	282
11											
12		48.4	60.0			108.4	5,036	162		197	1,249
13	0.1	69.2		3,169.6		3,238.8	16,672	128	none	590	9,755
14											
15		45.8		481.8		527.6	708	31	143	62	505
16											
17		3.4				3.4	1,638	61	561	823	1,056
18	2.2	199.0				199.0	3,836	78		511	1,837
19	30.0	21.2	19.3			40.5	1,015	56		none	325
20		53.8				53.8	1,410	101		78	
21						619.3	3,035	76	197	283	831
22											
23		262.2		1,170.9		1,433.1	†11,645	†72	none	247	
24							9,130	91	none	none	6,236
25				161.5		161.5				46	695
26	0.2						1,650	137	none	none	98
27				2,462.7		2,462.7	35,226	69	none	none	14,883
28	1.6	40.3				40.3	†7,077	†79	none	none	831
29					30.0	30.0	†1,447	†76	495	300	171
30		44.0				44.0					
31		51.9		266.7		318.6	3,879	26	none	147	3,316
32	0.4	17.4	150.0		50.0	217.4	2,434	110	709	130	705
33							2,055	86			none
34		377.3		850.7		1,228.0	15,706	81			
35		829.2	9,042.8			9,872.0	†188,220	†145	none	none	80,478
36	0.4		28.9			28.9	2,351	73			
37				325.0		325.0	6,500	186			375
38					29.7	29.7					
39											
40		7.5		34.8		42.3	5,582	93	none	none	3,145

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
1	1:1.2	37.0	¶			¶42.3				-5.3
2	1:1.8	117.0	10.7	20.0	15.5	20.0			¶40.8	50.8
3	1:1.9	1,309.6	208.3	3.3	446.4	502.0			¶500.4	149.6
4	1:1.5	453.3								
5	1:1.6	49.6	49.4			40.5				
6	1:2.1	52.6						†13.5	10.9	
7	1:1.5	27.8			6.1				¶9.9	21.7
8	1:1.8	976.6	223.7	78.4	598.3	*545.0			718.1	
9	1:1.6	180.0			71.9			151.0	25.0	-66.9
10	1:1.4	134.7	29.4		214.2			37.5		-146.4
11										
12	1:1.8	155.1	33.6	10.0	48.4	54.0				9.1
13	1:3.8	1,244.3	290.5		516.7	410.0				27.1
14										
15	1:2.0	172.6	7.6	82.0		55.0			10.6	17.4
16										
17	1:2.4	146.6	18.4		45.1	66.8		x2.0	¶54.9	14.3
18	1:3.7	423.0	62.2		199.0	87.0		51.3	¶54.6	23.5
19	1:1.6	93.0	11.4				49.7		¶22.1	31.9
20	1:2.1	123.5	0.9		24.6	8.0		90.0		
21	1:1.9	190.8	19.5			23.0		†97.4	¶39.1	50.9
22										
23	1:1.5	475.5	¶		262.2	¶143.6		2.8		66.9
24	1:1.6	411.5		384.2						27.3
25	1:1.1	19.8	19.1							0.7
26	1:1.7	36.8	2.0		22.5	16.0				-3.7
27	1:2.7	3,080.3	285.2	17.2	64.0	490.0		2,223.9		
28	1:2.1	319.4	23.0		40.3	92.0		100.0		
29	1:1.7	39.8	5.6	0.4					¶26.8	33.8
30	1:1.5	104.0			44.0			60.0		
31	1:3.4	856.0		292.0	54.0			510.0		
32	1:2.2	89.3	15.3			20.0			¶51.0	9.9
33	1:3.2	139.7							37.7	
34	1:3.5	2,091.5			374.3			s396.7	¶224.8	
35	1:2.9	6,907.0	1,801.1	2,141.0	829.2			2,135.7		
36	1:1.3	65.6	2.3		38.1	23.0				
37	1:0.9	-35.0	42.0	30.0	62.0	25.0			¶41.8	2.2
38	1:1.3	47.5	1.1			21.5				
39										
40	1:1.7	264.4	62.1	25.0	87.3	90.0			¶168.1	

# Ratio of expenses (Col. 17) to revenue (Col. 10).

¶ Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
41. Beaver Falls, Pa.	479.4	79.4	103.1	10.9	672.8	15.9	48.3
42. Beckley, W.Va.	248.6	59.9	8.7	1.1	318.3		8.1
43. Bellaire, Ohio							
44. Bellaire, Tex. <sup>10/88</sup>	273.0	5.2			278.2		
45. Bellingham, Wash.	179.0	245.4	†		424.4	2.3	16.0
46. Belmont, Mass.	†	196.7			196.7		
47. Bemidji, Minn.					34.7		4.0
48. Benton Harbor, Mich.					256.8		17.0
49. Berlin, N.H.	†	105.6	18.2		123.8		
50. Beverly Hills, Calif. <sup>7/88</sup>				1.2	689.7	13.1	1.0
51. Bexley, Ohio <sup>11/88</sup>	80.0	5.0			85.0		
52. Billings, Mont.	424.5	101.0	55.8	3.6	584.9	17.1	21.6
53. Binghamton, N.Y.	†	476.8			476.8		
54. Birmingham, Ala.	1,853.8	1,030.4	400.7	36.0	*3,482.9	108.3	104.7
55. Birmingham, Mich. <sup>7/88</sup>					225.2	0.9	11.5
56. Bismarck, N.D. <sup>7/88</sup>	210.4	89.8			300.2	5.7	3.6
57. Bloomfield, N.J.					473.8		
58. Bloomington, Ill. <sup>8/88</sup>				0.5	548.3		
59. Boone, Iowa	78.4	34.3			112.7		
60. Boston, Mass.				33.0	6,237.1		
61. Boulder, Colo.					346.4		8.4
62. Braddock, Pa.					76.4		
63. Bradenton, Fla.							
64. Bradford, Pa.	127.4	11.8	45.0	0.1	184.3		
65. Brawley, Calif. <sup>7/88</sup>	131.5	45.4	25.1		202.0		
66. Bremerton, Wash.							
67. Bridgeport, Conn.	†	2,825.5	997.0	1.4	3,823.9		560.1
68. Bristol, Tenn. <sup>8/88</sup>					190.8		
69. Bristol, Va.	95.1	105.7	†	1.9	202.7	0.9	18.9
70. Brockton, Mass.					458.9		
71. Brookline, Mass.	387.2	24.7			411.9		
72. Brownsville, Tex.					402.3		
73. Buffalo, N.Y.					3,443.1	42.7	122.4
74. Burbank, Calif. <sup>7/88</sup>	736.2	167.5	142.3	9.5	1,055.5	24.0	
75. Burlington, Iowa	198.2	141.8	†	1.0	341.0		
76. Burlington, N.J.	63.0	62.5		0.5	126.0		7.9
77. Burlington, N.C. <sup>7/88</sup>					404.5		14.3
78. Butte, Mont.							
79. Cambridge, Ohio					140.8		
80. Canton, Ohio	496.5	226.2	†		722.7		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.\$						\$1,000	\$/cap.\$
41	15.0	752.0	10.58	none	272.3	58.7			331.0	5.09
42	41.2	367.6	7.35	none	144.3	†	92.7		237.0	4.74
43										
44		278.2	12.65	41.7	144.0	16.6			160.6	7.30
45		442.7	11.36	none	321.6		13.9	24.9	360.4	9.24
46	7.1	203.8	6.79		77.2	92.4		35.3	204.9	6.83
47		38.7	3.87	0.1	17.9	3.0			20.9	2.09
48	17.8	291.6	13.26	none	70.6	52.7			123.3	5.61
49	0.2	124.0	6.89	11.0	57.5	†			57.5	3.20
50	1.7	705.5	16.41	none	412.4	21.1	6.3	72.1	511.9	11.91
51		85.0	6.06	10.8					15.0	1.07
52	50.5	674.1	11.23	none	276.3	†			276.3	4.61
53	39.1	515.9	5.43	63.3	391.0	†			391.0	4.11
54	72.0	3,767.9	7.39	none	1,211.6	291.8	21.0	16.5	1,540.9	3.02
55	12.3	249.9	10.86	none					103.5	4.50
56	19.5	329.0	14.30	none	39.4	108.5			147.9	6.43
57	115.1	588.9	11.32		105.3	147.5		75.5	328.3	6.31
58		548.3	14.42	61.9	192.1	95.2	0.1		287.4	7.56
59	6.9	119.6	9.20	7.0	72.7	18.1	2.3		93.1	7.16
60		6,237.1	8.78		473.3	5,705.9			6,179.2	8.70
61	26.9	381.7	11.92	none						
62		76.4	4.50	1.4					199.4	6.23
63		376.7	26.92						55.9	3.29
64	2.6	186.9	9.34	63.3	70.1	†			177.4	12.68
65	4.8	206.8	14.78		72.6	29.6			70.1	3.50
									102.2	7.31
66				none						
67	107.1	4,491.1	16.76	none	1,001.9	208.9	1,442.1	20.0	2,673.0	9.98
68		190.8	9.54	none	49.1	73.6		23.9	146.6	7.33
69	4.1	226.6	12.59		14.0	20.5			34.5	1.92
70		458.9	7.06	none	294.5	†			294.5	4.54
71	35.0	446.9	7.70	21.2	500.9	†			500.9	8.63
72		402.3	8.05	none	231.2				231.2	4.63
73	18.7	3,626.9	6.20						2,078.0	3.55
74	15.5	1,095.0	11.90		175.3	165.1	195.2		535.6	5.82
75	31.0	372.0	12.00	30.0	236.8	†			236.8	7.64
76		133.9	9.56	1.0	74.8	†			74.8	5.34
77	85.7	503.5	16.78	none	110.2	44.3			154.5	5.15
78										
79		140.8	7.82		74.2	60.8			135.0	7.50
80	105.0	827.7	6.09	85.6	516.5	281.5		51.5	849.5	6.25

† Included in preceding column.

‡ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earn- ings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23	\$1,000	\$/cap.‡			
41		223.6				223.6	6,135	94		2,800	3,860
42	25.2	48.7				48.7	1,912	38	437	977	253
43											
44		36.0				36.0	1,789	81		41	984
45	3.1	110.5				110.5	4,864	125	2,244	3,274	827
46							1,134	38		140	none
47		37.1				37.1	396	40		51	
48		33.6				33.6	2,551	116	563	361	1,975
49		32.8				32.8	677	38		553	120
50	0.9	46.6	1,083.0			1,129.6	3,457	80	2,091	1,794	2,846
51											
52				1,232.1		1,232.1	5,172	86	none	270	1,950
53		16.2				16.2					
54	0.6	1,367.8		1,512.9		2,880.7	29,723	59		4,571	24,570
55		23.9				23.9	2,027	88	796	302	312
56		12.7		340.0		352.7	2,176	95	579	1,020	1,231
57											
58	0.0	57.9	138.2	195.9		392.0	4,479	118	907	2,408	1,645
59	1.9	134.0				134.0	900	69	none	87	none
60		200.0				200.0	27,840	39			
61		63.1	458.1			521.2	4,170	130	none	413	2,280
62											
63							1,474	105			
64							3,162	158	none	none	1,950
65		17.4	63.6			81.0	1,058	75			
66											
67	32.2					1,793.9	‡30,461	‡114	116,599	2,681	10,300
68		75.4				75.4				183	200
69		13.1				13.1	3,239	180	none	228	2,305
70			1,800.0			1,800.0					
71							3,381	58			
72		33.9				33.9	4,044	81			
73							46,000	79			7,927
74							5,249	57	none	none	none
75		93.2		200.7		293.9					590
76		24.2		83.2		107.4	‡1,592	‡114	none	71	810
77		102.9				102.9					
78											
79							1,400	78			155
80							9,600	71		275	128

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
41	1:2.3	421.0	*102.0	28.4	177.0	80.0			7.2	26.4
42	1:1.6	130.6	11.1			29.0	15.0		38.1	55.0
43										
44	1:1.7	117.6	21.1	23.6		28.0			44.9	
45	1:1.2	82.3						t26.1		56.2
46	1:1.0	-1.1								-1.1
47	1:1.9	17.8								
48	1:2.4	168.3	43.8			65.0		t22.0	1173.8	
49	1:2.2	66.5	6.7		29.8	30.0			118.4	
50	1:1.4	193.6	19.4		46.6	40.0			1197.4	87.6
51										
52	1:2.4	397.8	40.6			50.0			125.6	181.6
53	1:1.3	124.9	5.5			40.0		x27.8		51.6
54	1:2.4	2,227.0	701.1	71.5	905.2	639.0		t121.5	11270.2	-211.3
55	1:2.4	146.4	6.8			12.0			1145.1	127.6
56	1:2.2	181.1	19.5	83.6	12.7	114.0			32.7	110.4
57	1:1.8	260.6	26.1		75.0	35.0		50.0		74.5
58	1:1.9	260.9	27.8			65.0		9.8	1172.6	158.3
59	1:1.3	26.5			26.5					
60	1:1.0	57.9							57.9	
61	1:1.9	182.3	69.2		63.1	50.0				
62	1:1.4	20.5	0.6			12.8				
63	1:2.1	199.3				149.9		7.1		
64	1:2.7	116.8	101.8	1.1	13.9					49.4
65	1:2.0	104.6	15.6		17.4	48.0			1138.4	
66										
67	1:1.7	1,818.1	321.7				748.0		11486.1	748.4
68	1:1.3	44.2	8.8			15.0		s16.1		4.3
69		192.1	62.9	47.1	2.1	80.0			1154.2	-11.0
70	1:1.6	164.4	180.0							-15.6
71	1:0.9	-54.0								
72	1:1.7	171.0								
73	1:1.7	1,548.9	307.9	269.0	6.5	528.7			18.7	
74	1:2.0	559.4	1.7					436.8		
75	1:1.6	135.2	13.0	1.0	93.2	28.0		d409.8	1137.0	147.9
76	1:1.8	59.1	21.7		24.2	30.0				-16.8
77	1:3.3	349.0	117.7		102.9	111.3				17.1
78										
79	1:1.0	5.8	14.6							
80	1:1.0	-21.8								

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
81. Cape Girardeau, Mo.	135.1	74.2			209.3	0.7	11.6
82. Carthage, Mo. <sup>7/66</sup>					136.0		
83. Cedar Falls, Iowa					132.2	2.1	
84. Cedar Rapids, Iowa	494.3	269.3		0.5	764.1		
85. Chambersburg, Pa.	81.7	11.4	30.7	0.1	123.9	1.5	12.0
86. Champaign, Ill.*	605.8	101.2	43.4	1.1	751.5	45.4	15.8
87. Charleroi, Pa.	272.0	32.5	181.0	14.9	500.4	18.3	
88. Charleston, S.C.					1,058.0		
89. Charleston, W.Va.	1,380.2	359.4	362.1	12.3	2,114.0		80.7
90. Charlotte, N.C. <sup>7/66</sup>							
91. Chicago, Ill.					31,068.8		
92. Clarksburg, W.Va.	177.7	119.3	150.1		447.1		
93. Clarksdale, Miss. <sup>10/66</sup>					156.6		
94. Cleburne, Tex. <sup>10/66</sup>				0.4	214.1		
95. Cleveland, Ohio				23.3	12,588.4		
96. Clinton, Iowa							
97. Cobb County, Ga.							
98. Coffeyville, Kan.					259.0		
99. Collinsville, Ill.							
100. Colorado Spgs., Colo.	518.0	198.3	136.8		853.1	25.6	
101. Columbia, Mo. <sup>10/66</sup>							
102. Columbia, S.C. <sup>7/66</sup>					972.3		
103. Columbia, Tenn. <sup>7/66</sup>	114.2	41.2	93.3		248.7		7.4
104. Columbus, Miss.					236.3		
105. Concord, N.H.	†	153.1	35.4		188.5		
106. Corpus Christi, Tex. <sup>9/66</sup>	1,293.0	1,198.7			2,491.7		
107. Coshocton, Ohio					147.0		
108. Council Bluffs, Iowa	324.1	20.5	193.8		538.4		
109. Covington, Ky.	†	372.7	96.5		469.2	282.4	
110. Crawfordsville, Ind.	111.2	39.8	26.5	2.7	180.2	6.7	17.3
111. Cudahy, Wis.	75.9	22.7	53.1	0.7	152.4		33.2
112. Cuyahoga Falls, Ohio	209.3	50.5	14.4		274.2		
113. Dallas, Tex. <sup>10/66</sup>	5,618.0	1,193.8	210.7		7,022.5	141.2	
114. Danville, Va.	149.8	54.4	31.5		235.7	7.4	37.2
115. Dayton, Ohio					2,147.7		
116. Dearborn, Mich. <sup>7/66</sup>					1,221.1	7.6	31.8
117. Decatur, Ala. <sup>6/66</sup>	196.5	71.7	64.7	5.9	338.8		15.6
118. De Kalb, Ill. <sup>6/66</sup>	160.0	17.0	30.0		207.0	1.0	
119. De Kalb County, Ga.					1,224.5		
120. Denison, Tex. <sup>9/66</sup>					288.7		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.‡						\$1,000	\$/cap.‡
81	1.2	222.8	9.28	none	89.7	17.1	55.2		162.0	6.75
82		136.0	11.33	15.2					57.7	4.81
83	2.0	136.3	8.02	0.3	47.8	16.0			63.8	3.75
84	143.0	907.1	11.34	80.6	383.0	101.9			484.9	6.06
85		137.4	6.87	7.6	68.9	‡		0.8	69.7	3.48
86	4.5	817.2	10.62	1.1	222.1	79.5	197.0		498.6	6.48
87	1.5	520.2	11.31							
88		1,058.0	7.29	54.9	375.5	62.6		331.0	769.1	5.30
89	32.3	2,227.0	12.04	none	943.3	139.4	421.4		1,504.1	8.13
90		1,733.1	9.64							
91	600.8	31,669.6	7.16	1,519.8	19,002.1	4,276.9		23.5	23,302.5	5.27
92	39.1	486.2	11.31	76.4	199.9	41.8			241.7	5.62
93	1.5	158.1	7.53	24.5	54.9	21.9			76.8	3.66
94		214.1	10.70		83.9	‡			83.9	4.19
95	630.9	13,219.3	10.33	360.0	5,600.0	1,613.4		54.5	7,267.9	5.68
96										
97					104.1	12.4		0.9	117.4	
98	14.2	273.2	12.41	1.0	100.0	89.5	0.3		189.8	8.62
99										
100	50.3	929.0	12.39	196.0	525.9	96.5			622.4	8.30
101										
102		972.3	9.17		246.7	44.8			291.5	2.75
103	0.1	256.2	13.49	none	103.2	13.1	4.7		121.0	6.37
104		236.3	12.43		82.7	19.3			102.0	5.37
105	0.4	188.9	6.75		103.6	10.8			114.4	4.09
106	54.3	2,546.0	14.15							
107		147.0	9.19		90.0	7.0			97.0	6.06
108	86.5	624.9	12.50	45.8	332.5	‡			332.5	6.65
109	6.5	758.1	3.79	54.8	378.8	31.4	12.7	9.8	432.7	2.16
110		204.2	14.59	none	63.0	15.5	59.6		138.1	9.87
111	1.6	187.2	11.70						118.4	7.40
112	68.8	343.0	8.37	5.5	137.5	71.1			208.6	5.09
113	238.6	7,402.3	12.66	223.4	3,269.6	247.8			3,517.4	6.01
114	35.6	315.9	6.32	none	140.6	22.2			162.8	3.26
115	96.3	2,244.0	7.01	142.6	1,532.3	‡	0.7	60.1	1,593.1	4.98
116	68.9	1,329.4	10.23	none	896.2	88.8			985.0	7.58
117	2.2	356.6	13.72	none	103.9	10.4			114.2	4.40
118	10.0	218.0	12.82		30.0	24.0			54.0	3.18
119	50.0	1,274.5	7.97							
120	6.9	295.6	14.08						166.4	7.93

‡ Included in preceding column.

§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depreciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.‡			
81	24.8					48.1	‡1,387	‡58	1191		
82							753	63			
83		61.8				61.8	628	37	456	50	none
84				147.5		147.5	4,426	55	none	54	1,454
85		26.6				26.6	1,529	76	188	4	737
86	24.1					404.9	‡5,190	‡67	11699		2,456
87							4,044	88	428	328	3,157
88		59.3		622.6		681.9	15,810	109	629		3,400
89	18.9					778.8	13,139	71	1,221		
90											
91		4,828.9		8,340.8		13,169.7	270,470	61		6,191	54,700
92		143.3				143.3	3,267	76	none	2,628	1,776
93							1,431	68	10		68
94		100.1				100.1	1,210	61		103	617
95						4,155.2	82,507	65	29,990	51,589	56,202
96											
97						none	3,425		107	217	3,100
98	0.1						1,348	61	135		263
99											
100		1,021.4		5,000.0		6,021.4	21,019	280	2,061	108	13,650
101											
102				189.5		189.5					4,685
103	1.8	70.1			†46.3	116.4	2,152	113	none	none	1,644
104						92.0	1,207	64	none	none	
105		55.9	26.2			82.1	2,492	89	925	13	140
106											
107		128.0				128.0					359
108						125.5	2,808	56	none	70	1,555
109	1.7			155.9		155.9	5,642	28	none	11	1,431
110	29.2					59.8	770	55			
111											
112		33.7				33.7	3,854	94	none	199	499
113			1,417.4			1,417.4	63,910	109			29,542
114		29.5	50.0	383.9		463.4	3,465	69	1,102		1,590
115	0.0	465.2		1,760.0		2,225.2	15,809	49	none	1,042	8,374
116		95.6				95.6	5,297	41	799	547	1,162
117						119.6	2,426	93	54	150	1,624
118		8.0		113.0		121.0	‡2,045	‡120	21	130	865
119							13,219	83			
120						none	3,368	160	none	53	1,682

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
81	1:1.4	60.8								
82	1:2.4	78.3			36.3				118.8	
83	1:2.1	72.5	2.4		23.1	20.0			23.3	3.7
84	1:1.9	422.2	21.8	36.8	293.6	70.0			1180.0	
85	1:2.0	67.7		40.6				40.0	1.2	
86	1:1.6	318.6	81.5		221.5		15.6		1109.8	
87										
88	1:1.4	288.9						200.0		88.9
89	1:1.5	722.9								
90										
91	1:1.4	8,367.2	1,441.3		2,425.9	4,500.0				
92	1:2.0	244.5	51.7						1150.7	192.8
93	1:2.1	81.3	3.9	14.7	40.1			x13.0	7.2	2.4
94	1:2.6	130.2	18.5	7.1	48.3	10.0			1128.7	46.3
95	1:1.8	5,951.4	1,205.7	762.7		1,227.0			1,463.5	1,292.5
96										
97			104.5	53.3	15.3				71.8	77.3
98	1:1.4	83.4	4.4		28.4	25.6			1167.8	25.0
99										
100	1:1.5	306.6	276.7	165.6		127.0			11219.3	
101										
102	1:3.3	680.8	120.3	34.9		258.0		267.6		
103	1:2.1	135.2	54.7	6.0	44.9	22.0			1146.2	7.6
104	1:2.3	134.3			92.0			33.9	1140.9	8.4
105	1:1.6	74.5	2.5		24.9	10.0			37.1	
106										
107	1:1.5	50.0		17.0		17.0				16.0
108	1:1.9	292.4	123.6		125.5				11120.3	43.3
109	1:1.8	325.4	48.5	136.8	9.0			131.1		
110	1:1.5	66.1							1116.4	
111	1:1.6	68.8								
112	1:1.6	134.4	17.9			34.0				
113	1:2.1	3,884.9	807.4	1,954.4	912.2					210.9
114	1:1.9	153.1	23.7					t64.8	1164.6	64.6
115	1:1.4	650.9	134.2		483.2	336.0			11389.5	-302.5
116	1:1.3	344.4	35.6	6.0	146.5	89.0				67.3
117	1:3.1	242.4	61.4	13.3	59.2	42.0		t12.0	46.9	7.6
118	1:4.0	164.0	36.5	12.0	7.2			96.0	4.8	7.5
119										
120	1:1.8	129.2	35.2	17.5	13.8	33.0		29.7		

# Ratio of expenses (Col. 17) to revenue (Col. 10).

¶ Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes": (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
121. Denton, Tex. <sup>6/88</sup>					365.1		
122. Denver, Colo.					5,846.4	31.7	137.0
123. Derby, Conn.	†	84.9	26.1	0.5	111.5		13.7
124. Des Moines, Iowa	†	2,156.5		2.0	2,158.5		29.7
125. Des Plaines, Ill.							
126. Detroit, Mich. <sup>7/88</sup>	6,228.5	3,087.1	2,828.6		*16,464.5		
127. Dodge City, Kan.					162.3		
128. Dover, N.J.					115.7		0.8
129. Dubuque, Iowa				4.2	409.0		
130. Duluth, Minn.				4.8	800.3		27.9
131. Durant, Okla. <sup>7/88</sup>	120.0	60.0			180.0		
132. Durham, N.C. <sup>7/88</sup>				25.9	899.2		44.2
133. Dyersburg, Tenn. <sup>7/88</sup>					120.9		
134. E. Bay M.U.D., Calif. <sup>7/88*</sup>	8,914.6	1,419.0	1,528.5		11,862.1	880.1	*2,541.1
135. East Detroit, Mich. <sup>7/88</sup>					192.2	208.6	
136. East Jefferson, La.					1,116.7		
137. East Lansing, Mich. <sup>7/88</sup>					128.0		3.3
138. East Orange, N.J.							
139. Eau Claire, Wis.	213.4	57.9	202.4	1.9	475.6	17.6	77.2
140. Ecorse, Mich. <sup>7/88</sup>							
141. El Centro, Calif.					262.8		
142. El Dorado, Kan.	†	480.0			480.0		
143. Elizabeth, N.J.	660.0	274.8	†		934.8		
144. Elizabeth City, N.C. <sup>7/88</sup>					151.9		
145. Elmira, N.Y.	412.7	150.9	†	7.7	571.3		14.6
146. Elwood, Ind.	†	90.9	10.3	1.6	102.8	2.4	15.3
147. Emporia, Kan.	101.8	48.5	†		150.3		
148. Endicott, N.Y.	†	276.0	169.8	4.2	450.0	9.7	52.0
149. Erie, Pa.	746.5	132.5	448.8		1,327.8		9.7
150. Escanaba, Mich. <sup>7/88</sup>					151.8	3.8	15.4
151. Eugene, Ore.	217.2	301.6	†		518.8	36.5	16.5
152. Evanston, Ill.					1,064.2		
153. Fargo, N.D. <sup>7/88</sup>	216.4	198.2			414.6		35.0
154. Faribault, Minn.					95.6		
155. Fayetteville, N.C. <sup>7/88</sup>	273.3	129.2			402.5		
156. Fergus Falls, Minn. <sup>8/88</sup>	48.2	13.4	34.8		96.4		6.8
157. Flint, Mich. <sup>7/88</sup>	1,219.7	1,471.9			2,691.6		16.2
158. Florence, Ala. <sup>10/88</sup>	267.3	36.8			304.1		14.2
159. Fort Collins, Colo.					267.8	12.0	
160. Fort Dodge, Iowa					219.5		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
Revenue (contd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	\$/cap.‡						\$1,000	\$/cap.‡	
121		365.1	13.03	none					256.9	9.17
122	281.4	6,306.5	11.47	none					2,392.8	4.35
123	1.1	126.3	12.63	none					97.1	9.71
124	3.6	2,191.8	10.19		818.2	288.4			1,106.6	5.14
125										
126	1,238.0	17,702.5	9.28						7,798.5	4.09
127		162.3	13.52	27.0					51.2	4.26
128	12.0	128.5	9.88	18.9	75.2	20.4	0.5		96.1	7.39
129	1.5	410.5	7.60	85.0	157.3	37.4			194.7	3.60
130	1.4	829.6	7.90	none	420.9	126.8			547.7	5.22
131		180.0	13.84		26.8	31.3			58.1	4.47
132	59.7	1,003.1	11.80	none	286.6	222.6			509.2	5.99
133		120.9	9.30		40.7	19.0			59.7	4.59
134	1,253.7	16,537.0	16.54	none	3,698.9	941.1	56.2	193.2	4,889.4	4.88
135		400.8	10.02	none	245.6	89.6			335.2	8.38
136	307.7	1,424.4	16.77						998.2	11.75
137		131.3	10.10	none	90.9	†			90.9	6.99
138				none						
139		570.3	15.84	none	235.6	†			235.6	6.54
140										
141		262.8	16.42		63.8	70.8		10.5	145.1	9.07
142		480.0	30.00						312.3	19.52
143	32.4	967.2	7.44	90.0	663.0	†			663.0	5.10
144	0.9	152.8	10.18		133.4	15.3			148.7	9.91
145	9.3	595.2	8.50	48.7	249.4	90.4	25.6		365.4	5.22
146	8.5	129.0	9.93						47.6	3.67
147		150.3	8.35	7.0	82.3	13.3			95.6	5.31
148		511.7	8.39		171.9	47.5	117.6	15.1	352.1	5.77
149	105.7	1,443.2	9.56	110.6	1,054.5	†		66.4	1,231.6	8.16
150	3.4	174.4	11.62	none	66.3	23.5			89.8	5.98
151		571.8	13.00	none	173.5	42.5			216.0	4.91
152	30.7	1,094.9	14.41	33.1	369.4	†			369.4	4.86
153	25.6	475.2	10.56		307.7	†	3.9		311.6	6.92
154	2.2	97.8	6.12	55.0	17.7	34.9			52.6	3.29
155	60.1	462.6	7.71	4.5	94.7	63.3			158.0	2.63
156	14.8	118.0	8.43	4.0	42.7	12.8		17.9	73.4	5.24
157	110.8	2,818.6	14.83	129.6	1,206.0	244.3	5.9		1,456.2	7.66
158	4.8	323.1	11.13	none	117.0	†			117.0	4.03
159	37.9	317.7	13.81	12.0					133.5	5.80
160	36.7	256.2	8.54	27.0	139.4	†			139.4	4.65

† Included in preceding column.

‡ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earn- ings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
121			50.7	1,012.0		1,062.7	2,484	89	83	none	95
122		1,910.6	3,000.9			4,911.5	64,550	117			36,742
123							752	75	1162	170	
124		616.2				2,434.4	11,716	55	4,288	10,830	1,933
125											
126		5,106.0		1,000.0		6,106.0	154,730	81	none	1,336	27,192
127		73.1				73.1	1,269	106	23	40	440
128	0.4	10.0				10.0	754	58	744	50	10
129		62.4		1,500.0		1,562.4	2,713	50	40		1,650
130		200.9				200.9	5,518	53	none	366	1,132
131		6.0				6.0	2,000	154			
132			203.5			203.5	\$9,755	\$115	none	none	4,508
133		70.0				70.0	630	48			
134	0.3	8,830.0			†857.0	9,687.0	†165,027	†165	1137,722	97,896	38,880
135					†277.1		1,831	46	none	55	55
136							10,855	128	890		10,000
137						none	433	33			
138											
139				1,154.3		1,154.3	\$4,430	\$123	none	160	1,937
140											
141			1,430.0			1,430.0	1,821	114			
142			442.0	1,350.0		1,792.0	3,829	240			
143		52.7				52.7	\$5,654	\$44	3,608	528	1,996
144							823	55	390		422
145	4.3	368.7				368.7	\$4,718	\$67	11328	16	none
146							633	49	69	133	917
147		16.2				16.2	1,726	96	none	none	191
148	23.0					89.3	\$2,638	\$42	11552	659	1,155
149		149.9	936.2			1,086.1	13,581	90	6,225	11,911	3,016
150		16.8				16.8	1,497	100	21	20	845
151		249.2				249.2	\$5,553	\$126	111,840	312	1,305
152							12,836	169			
153	0.8						3,804	85		215	1,575
154							1,771	111		40	none
155		607.8				607.8	5,616	94	none	none	none
156		35.1				35.1	885	63	245	27	88
157	0.2			797.5		797.5	16,060	85	none		10,285
158		67.3				67.3	3,643	126	none	none	2,302
159			1,500.0			1,500.0	2,761	120		469	1,867
160		80.5				80.5	2,633	88	none	none	none

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
121	1:1.4	108.2	26.6			33.0			82.4	
122	1:2.6	3,913.7	914.8	90.6	916.3	1,025.0			11967.0	
123	1:1.3	29.2			2.6		18.8			7.8
124	1:2.0	1,085.2	99.2	94.2					201.9	689.9
125										
126	1:2.3	9,904.0	2,598.3	1,983.3	2,800.0	1,186.0			113,303.6	1,336.4
127	1:3.2	111.1	40.6	39.9		25.0			28.6	-23.0
128	1:1.3	32.4	0.4		10.0			20.0	1.0	1.0
129	1:2.1	215.9	28.1	86.7	60.1				1160.6	40.0
130	1:1.5	281.9	20.3			76.9			1138.8	184.7
131	1:3.1	121.9			6.0			115.9		
132	1:2.0	493.9	146.0		0.5	195.3		1152.1		
133	1:2.0	61.2						14.7	1117.9	
134	1:3.4	11,646.7	1,690.1		7,852.5	2,105.0			112,673.0	
135	1:1.2	65.6								65.6
136	1:1.4	426.2								
137	1:1.4	40.4	1.9		10.0	5.0			16.5	7.0
138										
139	1:2.4	334.7	51.3	55.8	50.3	62.0		1107.9	1162.2	7.4
140										
141	1:1.8	117.7								
142	1:1.5	167.7								
143	1:1.5	304.2	126.1		45.1	133.0			11133.0	
144	1:1.0	4.1	14.0		24.8	23.1			11390.4	
145	1:1.6	229.8			229.8				1153.1	
146	1:2.7	81.4	34.8	2.0	13.8					30.8
147	1:1.6	54.7	4.0		16.2	19.0			1139.2	15.5
148	1:1.5	159.6	47.6		69.0				1143.0	43.0
149	1:1.2	211.6	42.4		150.9				11277.9	18.3
150	1:1.9	84.6	22.4			25.0		1119.6		0.8
151	1:2.6	355.8	29.2	157.8	114.1	352.0			1154.7	-297.3
152	1:3.0	725.5	57.1							
153	1:1.5	163.6	38.6						56.8	68.2
154	1:1.9	45.2								5.0
155	1:2.9	304.6			304.6					
156	1:1.6	44.6	1.9	1.2	35.1	7.0			1112.8	27.0
157	1:1.9	1,362.4	267.7	50.0	168.0	245.0		1120.0	11439.5	511.7
158	1:2.8	206.1	86.0	20.0	55.8	11.0		1133.3		
159	1:2.4	184.2	44.2			113.0			1154.1	27.0
160	1:1.8	116.8			80.5					36.3

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
161. Fort Madison, Iowa				1.3	109.0	0.1	11.5
162. Fort Scott, Kan.					111.9		4.9
163. Fort Wayne, Ind.	832.4	704.3	†	11.9	1,548.6	28.7	71.1
164. Fostoria, Ohio	83.5	44.2	†		127.7		
165. Frankfort, Ky. <sup>7/86</sup>					158.4		
166. Franklin, Ind.	77.4	24.3	30.8	0.4	132.9	5.9	12.6
167. Franklin, Pa.	96.8	5.4	7.4		109.6		
168. Fredericksburg, Va. <sup>7/88</sup>					180.6		7.0
169. Freeport, Ill. <sup>10/88</sup>	†	228.6	38.2	3.8	270.6	5.6	30.3
170. Fremont, Neb.					94.0	4.4	
171. Fresno, Calif. <sup>7/88</sup>	1,068.0	471.6	†		1,539.6	28.7	8.7
172. Fullerton, Calif. <sup>7/88</sup>					542.8		
173. Fulton, Mo. <sup>7/88</sup>	42.1	19.5	4.3		65.9		
174. Gainesville, Ga.					278.9		
175. Garden City, N.Y. <sup>8/88</sup>					372.7	6.1	
176. Gary, Ind.	1,043.5	375.4	171.7	5.3	1,595.9	63.4	99.8
177. Gastonia, N.C. <sup>7/88</sup>					448.4		
178. Glen Cove, N.Y.	†	182.1	21.5	2.8	206.4	4.9	22.0
179. Glendale, Calif. <sup>7/88</sup>					1,334.3		40.6
180. Gloversville, N.Y.							
181. Goldsboro, N.C.				12.5	223.3		
182. Goshen, Ind.					64.1		10.7
183. Grand Island, Neb. <sup>8/88</sup>					178.0	8.4	6.0
184. Grand Junction, Colo.					407.0		
185. Grand Rapids, Mich. <sup>7/86</sup>	827.1	336.8	393.8	29.1	1,586.8		121.6
186. Great Bend, Kan.	167.1	50.4			217.5		13.3
187. Green Bay, Wis.	201.1	76.5	110.0	3.4	391.0	8.3	74.5
188. Greensboro, N.C. <sup>7/88</sup>					1,168.3		
189. Greenville, Miss. <sup>10/88</sup>	217.5	82.5	72.5		371.5		
190. Greenville, N.C. <sup>7/88</sup>					238.2		
191. Greenville, S.C. <sup>8/88</sup>	690.6	218.5	188.8	12.8	1,110.7		
192. Greenwood, Miss. <sup>10/84</sup>				1.7	150.2		
193. Greenwood, S.C.	†	113.4	49.2	1.4	164.0		
194. Griffin, Ga. <sup>12/84</sup>	137.9	134.3	†		272.2		
195. Haddonfield, N.J.					89.1		
196. Hagerstown, Md.	438.4	14.2	†	6.2	458.8		22.5
197. Hamilton, Ohio	473.1	194.2	92.7		760.0		
198. Hammond, Ind.	553.4		407.7		961.1	4.2	70.6
199. Hannibal, Mo. <sup>6/88</sup>					185.2		
200. Hanover, Pa.	163.6	27.1	29.0	5.9	225.6	1.2	1.7

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18	
	Revenue (contd.)			Free Service Value \$1,000	Expenses						
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
		\$1,000	\$/cap.‡						\$1,000	\$/cap.‡	
161	5.0	125.6	8.37	15.8	75.7	‡	2.3	2.0	78.0	5.2	
162		116.8	11.68								
163	20.3	1,668.7	11.92		1,044.0	‡	27.6		1,073.6	7.67	
164	6.3	134.0	8.37		91.0	11.4			102.4	6.40	
165		158.4	7.92	none							
166		151.4	15.14	none	37.4	11.4	49.1	0.9	97.9	9.79	
167	14.6	124.2	8.87	0.1	62.5	34.8			97.3	6.95	
168		187.6	12.50		35.0	4.0			39.9	2.66	
169		306.5	9.58		117.1	30.2			147.3	4.60	
170		98.4	5.47						76.1	4.23	
171	77.4	1,654.4	12.73	6.1	447.8	‡	2.8	363.9 87.9	811.7	6.25	
172		542.8	13.23		234.8	90.4			413.1	10.07	
173		65.9	5.49		44.7	‡			47.5	3.96	
174		278.9	13.95						142.4	7.12	
175		378.8	18.02	none	252.8	‡			252.8	12.02	
176	20.0	1,779.1	9.73	0.3	557.4	168.7	467.2		1,193.3	6.53	
177		448.4	8.79	0.7	111.6	68.9			180.5	3.54	
178	3.7	237.0	11.85		74.0	14.6	90.4		179.0	8.95	
179	48.7	1,423.6	12.71	none					823.6	7.35	
180		168.3	7.02		142.2	50.0			192.2	8.02	
181	22.6	245.9	8.19	1.2	95.9	11.6	0.7		107.5	3.58	
182	5.1	79.9	6.15		60.8	‡			61.5	4.73	
183	8.2	200.6	8.03	none	71.5	22.1			93.6	3.75	
184		407.0	16.28		75.0	‡			75.0	3.00	
185	278.9	1,987.3	10.14	none	1,342.1	‡			1,342.1	6.85	
186	0.4	231.2	11.01	none	36.3	32.1			68.4	3.26	
187	4.6	478.4	7.97			194.8			50.7	245.5	4.09
188		1,168.3	12.70			274.9			133.4	418.3	4.55
189		371.5	9.28		7.1	91.6			114.2	205.8	5.14
190		238.2	13.23	none					118.5	6.58	
191	137.8	1,248.5	7.57	225.0	236.1	111.7	0.4		347.8	2.11	
192	8.1	158.3	8.34	33.6					57.5	3.03	
193		164.0	7.13	8.4	81.2	31.1			112.3	4.89	
194	11.0	283.2	11.32	33.9	98.2	24.9			123.5	4.94	
195		89.1	7.42		40.6	14.6			55.2	4.60	
196	54.2	535.5	10.92	none	237.5	‡	0.3 10.5	2.3	237.5	4.84	
197	31.6	791.6	11.31	32.7	311.1	106.7			420.4	6.00	
198	137.6	1,173.5	11.73	none	547.9	‡			558.4	5.58	
199		185.2	8.82	15.4	77.0	129.1			206.1	9.82	
200	13.5	242.0	10.52	4.9	88.2	25.8	0.2		114.2	4.97	

‡ Included in preceding column.

§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earn- ings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.‡			
161	1.8	20.0				20.0				138	360
162							615	62			
163	1.7	386.6		720.7		1,107.3	11,279	81	46	4,979	5,896
164											
165											
166	32.4					10.6	581	58			
167							795	57		3	
168		74.0				74.0	744	50			56
169		378.5				378.5	1,285	40	11433	504	949
170											
171							5,429	42	111,958	none	843
172		686.2				686.2	2,108	51			
173	4.2						497	41			
174						none	1,072	54			1,581
175						none	1,532	73	443	214	297
176	26.3					839.5	11,491	163	2,118	819	5,300
177				239.7		239.7	4,869	96	none	none	3,163
178	38.2						1,028	51	218		
179		444.4		93.7		538.1	14,151	126	none	none	1,350
180						38.9	2,026	84			
181		67.0	1,033.0			1,100.0					
182	0.9	5.4				5.4	681	52	71		
183		71.0				71.0	915	37	644		none
184		180.0	1,500.0			1,680.0					
185		329.3		721.9		1,051.2	12,475	64			3,170
186											
187				5,700.0		5,700.0	3,522	59	830	1,222	6,140
188		269.4	863.7			1,133.1	18,217	189	none	353	5,107
189			145.0			145.0	2,498	62	none	20	250
190											
191		163.9		2,237.7		2,401.6	12,004	73	none	1,503	7,310
192		67.5				67.5	628	33	185	45	none
193				30.0		30.0					
194						none	2,348	94	572		
195						3.0	583	49			
196						208.0					
197	0.0		100.0	886.9		986.9	5,066	72	191	262	3,074
198	0.9			1,622.6		1,622.6	8,191	82	none	none	3,790
199						63.5	11,614	177			
200	0.1						1,758	76			547

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
161	1:1.6	47.6	11.4	25.0	11.2					
162			7.4			37.0		3.9	112.4	17.6
163	1:1.6	595.1	156.0	25.4	213.7	200.0			1124.1	
164	1:1.3	31.6	15.3							
165										
166	1:1.5	53.5								
167	1:1.3	26.9							112.8	
168	1:4.7	147.7	1.0		74.0	8.0		64.7		
169	1:2.1	159.2	34.3	31.0					78.8	
170	1:1.3	22.3								
171	1:2.0	842.7	39.5		705.2	68.0		130.0	1141.1	
172	1:1.3	129.7			129.7					
173	1:1.4	18.4						18.4		
174	1:2.0	136.5								
175	1:1.5	126.0	5.2		21.9				48.3	50.6
176	1:1.5	585.8	200.5						1153.2	385.3
177	1:2.5	267.9	101.2		75.0	99.8				-8.1
178	1:1.3	58.0								
179	1:1.7	600.0	26.7		190.4	75.0		1590.0	254.0	-536.1
180	1:0.9	-23.9								
181	1:2.3	138.4	31.1			41.3		66.0		
182	1:1.3	18.4			8.0				10.4	
183	1:2.1	107.0							34.6	72.4
184		332.0	¶		80.0	¶147.0				105.0
185	1:1.5	645.2	33.1	19.2		90.0			1139.4	502.9
186	1:3.4	162.8								
187	1:1.9	232.9	25.2		31.7	57.0		170.6	48.4	
188	1:2.8	750.0	158.2		376.1	184.8				30.9
189	1:1.8	165.7				60.9		84.8		20.0
190	1:2.0	119.7								
191	1:3.6	900.7	154.2	280.2		302.0			164.3	
192	1:2.8	100.8			53.2			26.0	1121.6	21.6
193	1:1.5	51.7								
194	1:2.3	159.7	76.0	38.7		45.0			1160.9	
195	1:1.6	33.9								
196	1:2.3	298.0	80.9						80.6	
197	1:1.9	371.2	85.9	37.2	40.9	131.0				76.2
198	1:2.1	615.1	87.7	312.3	105.1	110.0			1163.9	
199	1:0.9	-20.9							1123.4	
200	1:2.1	127.8	31.2		56.8	47.0			1129.0	-7.2

# Ratio of expenses (Col. 17) to revenue (Col. 10).

¶ Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
201. Harlingen, Tex.					362.6		9.7
202. Hartford, Conn.*				1.1	2,609.0	172.5	25.4
203. Hastings, Neb.					183.8	2.2	
204. Haverstraw, N.Y.	†	127.8	31.5	2.8	162.1	4.3	22.5
205. Helena, Ark.	55.1	38.8	†	3.1	97.0		6.3
206. Hibbing, Minn.							
207. Highland Park, Mich. <sup>7/55</sup>	107.3	101.3	311.3		519.9		
208. Hilo, T.H.*				0.3	447.7		
209. Holland, Mich.				1.1	219.3	1.4	21.1
210. Hollywood, Fla. <sup>10/55</sup>					515.6		
211. Honolulu, T.H.	1,744.0	1,481.4	370.4	19.7	3,615.5	4.5	
212. Hopkinsville, Ky. <sup>6/55</sup>	170.6	56.3	24.2	3.6	254.7	8.2	9.4
213. Hoquiam, Wash.					136.7	2.3	
214. Hot Springs, Ark.	161.0	158.9	11.7	4.3	335.9	1.1	6.4
215. Houston, Tex.	†	6,259.2	380.9		6,640.1		
216. Huntington Pk., Calif. <sup>7/55</sup>					286.0		
217. Hutchinson, Kan. <sup>2/55</sup>							
218. Independence, Kan.					120.6		
219. Independence, Mo.	630.8	127.8	46.8	1.2	806.6		42.6
220. Indianapolis, Ind.	4,635.0	1,368.4	1,223.8	66.9	7,294.1	58.0	533.0
221. Ironton, Ohio <sup>2/55</sup>	122.1		10.7		132.8		
222. Ithaca, N.Y.					205.6		7.8
223. Jackson, Mich. <sup>7/55</sup>	256.5	198.4	†		454.9		
224. Jacksonville, Fla.					1,798.6	33.0	56.4
225. Jacksonville, Ill.					300.4		
226. Jamaica, N.Y.	3,110.1	1,113.8	†	40.8	4,264.7		442.8
227. Jamestown, N.Y.	204.8	79.5	107.0	4.4	395.7	23.1	37.3
228. Janesville, Wis.	95.0	26.6	38.1	2.5	162.2	4.4	32.4
229. Jefferson City, Mo.	152.7	74.8	9.4	2.0	238.9	19.0	
230. Jeffersonville, Ind.	196.6	55.3	39.5	1.5	292.9	9.7	32.4
231. Johnson City, N.Y. <sup>6/55</sup>							
232. Johnstown, N.Y.	35.0	43.9	†		78.9		
233. Jonesboro, Ark.					126.8		
234. Junction City, Kan.					138.1		
235. Kalamazoo, Mich.				8.6	696.3	2.9	52.3
236. Kankakee, Ill.	292.3	205.4	149.8	4.9	652.4		17.6
237. Kansas City, Mo. <sup>5/55</sup>	1,820.5	2,351.1		10.5	*5,341.3		
238. Kearney, Neb.	54.9	24.8			79.7	4.6	
239. Kennewick, Wash.					256.1		2.6
240. Kenosha, Wis.	252.9	78.1	134.5	6.1	471.6	27.3	120.4

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.‡						\$1,000	\$/cap.‡
201	11.5	383.8	11.62	none	205.0	‡			205.0	6.21
202	49.6	2,856.5	8.40	none	1,150.4	495.0			1,645.4	4.84
203		186.0	7.44	none	82.0	‡			82.0	3.28
204	0.6	189.5	17.24		62.8	17.8	68.9		149.5	13.60
205	4.2	107.5	9.78		49.8	‡	0.3	20.9	71.0	6.46
206										
207	592.3	1,112.2	24.20		190.7	353.0		413.1	956.8	20.82
208	6.7	454.4	13.77		207.7	46.9			254.6	7.72
209	2.2	244.0	12.84		74.3	‡			74.3	3.91
210		515.6	10.31		119.0	12.6			131.6	2.63
211	81.3	3,701.3	14.23	none	2,123.3	‡			2,123.3	8.16
212	6.0	278.3	13.92	none	88.7	20.4			109.1	5.46
213	2.0	141.0	10.84		71.5	‡	4.7	6.0	82.2	6.32
214	7.8	351.2	10.64	1.9	137.1	29.2			166.2	5.04
215		6,640.1	9.16	680.0	3,638.0	‡			3,638.0	5.02
216		286.0	9.53	71.5	83.7	65.2			148.9	4.96
217										
218	7.8	128.4	8.56		51.0	19.3			70.3	4.69
219	11.4	860.6	12.48	517.6	493.9	53.2	66.8	6.7	620.6	9.00
220	56.1	7,941.2	15.36	none	1,906.4	360.8	2,862.8		5,130.0	9.92
221	6.1	138.9	8.68		102.5	39.0			141.5	8.84
222	44.8	258.2	7.59	8.0	33.7	162.4	6.2	13.5	215.8	6.35
223	74.8	529.7	9.63		289.8	65.0		18.0	372.8	6.78
224	64.4	1,952.4	6.51						1,109.5	3.70
225		300.4	12.01	6.5	37.8	99.0			136.8	5.47
226	35.2	4,742.7	8.65		1,429.5	518.8	1,363.7	127.6	3,439.6	6.27
227	4.3	460.4	9.20	none	188.7	50.4	21.0		260.1	5.20
228	8.8	207.8	6.93	none	68.0	41.5		0.2	109.7	3.66
229	5.3	263.2	9.40		132.2	6.3	47.9		186.4	6.66
230		335.0	12.89	none	94.8	27.4	99.6		221.8	8.53
231		161.2	6.20						144.3	5.55
232	4.7	83.6	7.60						66.0	6.00
233		126.8	7.05	15.0	46.1	18.7			64.8	3.60
234	37.0	175.1	10.94	36.0	22.0	40.2			62.2	3.89
235	72.8	824.3	9.93	none	235.5	66.1		38.2	339.8	4.09
236	19.6	689.6	14.07		323.3	53.6	93.9	3.8	474.6	9.68
237	20.3	5,361.6	7.53		3,163.9	133.1			3,297.0	4.63
238	14.2	98.5	7.58	none	51.1	13.2			64.3	4.95
239	1.5	260.2	13.01		72.6	35.4	7.7	4.6	120.3	6.02
240	8.9	628.2	10.47		304.4	‡	0.6	59.2	364.2	6.07

‡ Included in preceding column.  
§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23	\$1,000	\$/cap.\$			
201							2,044	62	492		1,261
202		1,673.8		426.8	*1,132.6	3,233.2	‡49,718	‡146	8,322		12,394
203		3.3				3.3	1,069	43	323		
204	36.4						621	56	‡189		
205	0.3	103.3		389.0		492.3	514	47	18	375	389
206											
207		176.0				176.0	2,332	51	1,025	578	none
208		49.7			*99.3	149.0	3,216	97		130	
209						47.1	579	30	481	137	2,700
210		79.7				79.7	2,791	56	191	66	1,424
211		76.2		343.4		419.6	25,009	96		275	7,909
212		18.9		252.4		271.3	1,617	81	30		1,047
213	4.3						‡880	‡68	496	383	
214		49.3	17.5			66.8	‡3,830	‡116	27	none	2,366
215		1,205.2		1,520.6		2,725.8	60,465	83		1,377	40,731
216		66.0				66.0	949	32	636	none	none
217											
218		25.2				25.2	748	50		135	none
219	7.8					1,028.9	4,709	68	‡467		
220	36.1	2,522.8	3,000.0		-1,150.0	4,372.8	46,520	90	‡4,142		22,275
221						none					200
222	2.4					none	4,749	140			659
223							1,477	27		60	
224							13,500	45		9,344	4,910
225			1,250.0	942.9		2,192.9	3,634	145	563	1,117	2,985
226	28.8					2,040.0	‡25,187	‡46	4,307	1,025	10,395
227	4.6	118.5				118.5	‡3,134	‡63	704	2,007	50
228		293.0				293.0	1,837	61	464	1,013	none
229	18.2					84.4	1,502	54			
230	29.7					105.0	1,393	54			
231										134	none
232							820	46			
233						236.7	299	19	none	none	211
234		11.7		225.0							
235		496.3				496.3	4,457	54	1,227	132	none
236	13.6					118.0	4,021	82	459		2,200
237		5,643.3				5,643.3	54,371	76	14,125	16,964	30,038
238		36.6				36.6	‡613	‡47	none	none	none
239	3.0					375.4	1,751	88			1,510
240	0.1	142.7				142.7	4,005	67	869		

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
201	1:1.9	178.8	36.2	6.3	62.6	30.0		t16.4	1189.0	27.3
202	1:1.7	1,211.1	284.9	*534.8	279.1			t88.9	11483.0	23.4
203	1:2.3	104.0						t11.7	1118.0	92.3
204	1:1.3	40.0								
205	1:1.5	36.5	7.9	1.1					11.9	
206										
207	1:1.2	155.4			130.7			24.7	1137.1	
208	1:1.8	199.8	62.0	25.8	25.8	30.0		-16.7	1198.5	92.4
209	1:3.3	169.7	19.6		47.1				30.4	72.6
210	1:3.9	384.0		89.0	79.7			25.0	35.0	155.3
211	1:1.7	1,578.0	207.4		529.2				766.3	75.1
212	1:2.6	169.2	35.0	14.0	48.1	27.0			1137.2	45.1
213	1:1.7	58.8							13.2	
214	1:2.1	185.0	80.8	6.5	7.3	60.0		t13.1	17.3	
215	1:1.8	3,002.1	1,023.6	765.5	75.0					1,138.0
216	1:1.9	137.1								137.1
217										
218	1:1.8	58.1			25.2					6.4
219	1:1.4	240.0								
220	1:1.5	2,811.2	639.6		1,309.1		603.2		11475.0	259.3
221	1:1.0	-2.6								
222	1:1.2	42.4	2.7		13.7	10.0		s16.0		
223	1:1.4	156.9	13.0						64.4	79.5
224	1:1.8	842.9	98.5	184.6					62.6	497.2
225	1:2.2	163.6	35.0	42.5		36.5			9.9	1.9
226	1:1.4	1,303.1	318.4				473.3		358.5	
227	1:1.8	200.3	2.8		90.8	10.0		35.0	1161.7	61.7
228	1:1.9	98.1						t42.3	17.8	38.0
229	1:1.4	76.8								
230	1:1.5	113.2							1130.7	
231	1:1.1	16.9								
232	1:1.3	17.6						t11.1		6.5
233	1:2.0	62.0			57.3			t4.7	1128.6	
234	1:2.8	112.9			22.9	34.1				55.8
235	1:2.4	484.5			299.2			t65.0	117.7	2.6
236	1:1.5	215.0	67.6		24.1		50.0	x15.6	57.7	
237	1:1.6	2,064.6	623.3			951.0			584.9	
238	1:1.5	34.2			34.2				111.5	
239	1:2.2	139.9	52.7	25.0	50.5			t11.7		
240	1:1.7	264.0	9.5			20.0		t76.2	1159.8	15.0

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
241. Kent, Ohio	75.7	31.5	†		107.2		
242. Keokuk, Iowa	96.0	16.0	50.0	1.0	163.0	0.2	2.4
243. Key West, Fla. <sup>9/88*</sup>					820.0		3.8
244. Kirksville, Mo.					105.7		
245. Klamath Falls, Ore.	219.8	92.0	9.8	2.3	323.9	6.8	16.0
246. Knoxville, Tenn.				16.5	1,526.5	51.2	80.3
247. Laconia, N.H.				2.2	106.2	6.5	35.3
248. La Crosse, Wis.	158.2	64.8	79.5	3.0	305.5	11.8	91.7
249. Lafayette, La. <sup>10/88</sup>	285.4	25.0			310.4	0.9	15.9
250. Lake Worth, Fla. <sup>11/88</sup>					278.1		
251. Lakeland, Fla. <sup>9/88</sup>					417.0	8.1	33.3
252. Lakewood, Ohio	304.4	39.8	66.0	0.3	410.5	9.4	
253. La Mesa, Calif.*							
254. Lancaster, Ohio							
255. Laredo, Tex.					512.6	12.0	
256. Las Cruces, N.M. <sup>7/88</sup>							
257. Las Vegas, Nev. <sup>7/88</sup>					1,223.7	10.4	0.9
258. Latrobe, Pa. <sup>4/88</sup>					389.9		
259. Lawrence, Kan.					408.0	3.0	4.5
260. Leavenworth, Kan.					236.4		
261. Lebanon, Pa.	236.7	43.9	87.0		367.6	15.8	2.1
262. Lewiston, Idaho <sup>7/88</sup>					189.7		
263. Lewistown, Pa.	116.7	15.4	40.5	7.9	180.5	3.7	6.1
264. Lima, Ohio					611.7		
265. Lincoln, Neb. <sup>9/84</sup>	568.1	418.3		1.8	988.2	110.9	
266. Lincoln Park, Mich. <sup>7/88</sup>					285.5		
267. Little Rock, Ark.	793.0	418.3	130.3	1.2	*1,551.6	84.4	38.9
268. Logansport, Ind.				1.4	254.0		16.2
269. Long Beach, Calif. <sup>7/88</sup>					3,259.6	25.9	
270. Long Island, N.Y.*	2,180.8	309.6	9.2	4.5	2,504.1		186.4
271. Longview, Wash.					236.6		14.5
272. Lorain, Ohio	312.6	7.7	126.7		447.0		
273. Los Angeles, Calif. <sup>7/88</sup>	16,876.2	8,069.5	272.8	*295.5	25,218.5	1,105.8	1,200.4
274. Louisville, Ky.	2,162.5	1,163.3	944.3		4,270.1		
275. Lynchburg, Va. <sup>7/88</sup>					625.5	8.6	20.7
276. Madison, Wis.	333.9	207.3	72.0	6.4	619.6	35.6	135.7
277. Manchester, Conn.	†	182.0	5.1	2.2	189.3	4.0	31.9
278. Manchester, N.H.	†	470.6	155.0	20.0	645.6		
279. Manhattan, Kan.					238.4		
280. Manhattan B., Calif. <sup>7/88*</sup>							2.1

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
Revenue (contd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	\$/cap.\$						\$1,000	\$/cap.\$	
241	7.9	115.1	9.60	20.0	58.4	16.4		2.9	77.7	6.48
242	11.0	176.6	11.03	2.6	41.5	40.0			81.5	5.09
243	77.2	901.0	22.52	none	621.0	†			621.0	15.52
244		105.7	8.80		74.2	‡			74.2	6.18
245	0.2	346.9	15.09	none	98.7	20.7	96.3		215.7	9.38
246	27.2	1,685.2	9.91	none	616.7	413.4	1.8		1,031.9	6.07
247	2.1	150.1	10.72		69.5	‡	27.7		97.2	6.94
248	1.3	410.3	8.55						225.2	4.69
249	6.5	333.7	8.78		193.4	35.8			229.2	6.03
250	17.5	295.6	12.85		36.8	28.6		57.4	122.8	5.34
251		458.4	9.56	none	204.5	41.2			245.7	5.12
252	26.2	446.1	6.37						428.3	6.12
253		5,442.7							4,961.7	
254										
255	6.3	530.9	8.29	none	219.7	24.4			244.1	3.81
256										
257	76.6	1,311.6	27.90	none	322.8	‡		25.1	347.9	7.40
258	9.4	399.3	19.97						151.8	7.59
259		415.5	16.62	none	142.7	11.4			154.1	6.17
260	3.0	239.4	9.97		64.5	59.3			123.8	5.15
261	64.2	449.7	8.17	30.2					230.8	4.19
262		189.7	14.58	8.7	106.8	31.5			138.3	10.63
263	13.5	203.8	8.15	none	80.2	‡		1.1	81.3	3.25
264		611.7	8.49		220.5	196.3			416.8	5.78
265	42.6	1,141.7	9.06	none	432.9	43.2		1.4	477.6	3.79
266	22.5	308.0	6.42	8.0	202.0	24.6			226.6	4.72
267	41.8	1,716.7	12.63		388.1	127.2			515.3	3.79
268	1.4	271.6	10.86	none	95.7	4.6	2.5		102.8	4.11
269	134.9	3,420.4	11.88	265.2	1,385.0	419.5	1.0	11.7	1,817.2	6.31
270	14.7	2,705.2	13.00	none	840.9	‡	938.7		1,779.6	8.55
271	1.4	252.5	8.42	16.5	76.9	17.5	6.1	1.6	102.1	3.41
272	118.3	565.3	8.98	49.7	199.0	68.4			267.4	4.25
273	1,460.4	28,985.1	12.98	none	9,779.4	4,705.3	647.6		*14,711.5	6.59
274	14.3	4,284.4	8.57	269.5	2,487.2	‡		41.6	2,528.8	5.06
275	17.0	671.8	11.78	none	74.5	107.3			181.8	3.19
276	68.5	859.4	7.35	none	361.7	86.8		12.2	460.7	3.94
277	2.2	227.4	9.47		78.1	14.1			92.2	3.84
278		645.6	7.43	100.2			22.3			
279	15.0	253.4	12.07						171.5	8.17
280		385.0	12.02							

† Included in preceding column.  
‡ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earn- ings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
241		10.4				10.4	473	39	none	26	155
242		76.9				76.9	1,075	67			
243							1,264	32	none		594
244											
245	27.8					52.1	1,725	75	445	35	1,986
246	0.1					1,115.6	7,075	42	none	none	2,658
247	18.5	30.0				30.0	770	55		200	250
248							2,816	59	755	632	
249		66.4		222.2		288.6	4,472	118	none	none	none
250							1,627	71			964
251				130.8		130.8					
252		17.2				17.2					
253						142.9	8,137	120	none	none	3,571
254											
255							3,658	57	none	none	2,777
256											
257		68.3	2,506.5			2,574.8			none	474	8,700
258							3,227	161		1,323	2,291
259				1,249.1		1,249.1	6,004	240	422	211	
260		34.6				34.6	944	39	none	219	none
261							4,765	87	50		2,071
262		41.7				41.7	1,524	117	none	200	none
263							1,977	79			1,425
264		63.2				63.2					
265		344.9		4,300.6		4,645.5	15,977	127	2,641	8,654	5,740
266		55.9				55.9	2,636	55		93	138
267							13,450	99	338	1,576	7,381
268	0.9	34.2				34.2	1,280	51	42		
269	0.0	530.3				530.3	22,113	77	none	none	5,070
270	34.7						14,968	72			8,294
271	2.4	192.5				192.5	2,573	86	412	555	746
272		98.2	29.4			127.6	7,808	124		222	1,489
273	2.2	5,974.9		9,000.0	†2,902.7	17,877.6	317,768	142	1182,882	1197,736	88,199
274		1,126.5		1,724.1		2,850.6	25,850	52	none	5,061	9,275
275		203.8			426.8	630.6	15,134	190	43	26	891
276						513.5	6,346	54	1,155	2,027	901
277			600.0			600.0	2,807	117	620	none	1,218
278	3.5	3.6				3.6	7,451	86			
279		28.1				28.1	1,971	94		1,855	1,485
280											

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
241	1:1.5	37.4	3.8	2.2	10.4	5.0			1125.0	16.0
242	1:2.2	95.1	2.0		76.9				115.0	16.2
243	1:1.5	280.0	21.2		161.8	21.0			1148.6	76.0
244	1:1.4	31.5	13.1	0.4		15.0				3.0
245	1:1.6	131.2	45.2				57.8		1128.2	28.2
246	1:1.6	653.3	84.3			161.0		t95.0	1141.4	
247	1:1.5	52.9	9.1	5.6		10.0			1118.9	28.2
248	1:1.8	185.1						t44.0	42.8	98.3
249	1:1.5	104.5	43.3			137.2			1176.0	-76.0
250	1:2.4	172.8	25.8		70.4	56.3		20.3		
251	1:1.9	212.7	44.4		153.3					
252	1:1.0	17.8								17.8
253	1:1.1	481.0								
254										
255	1:2.2	286.8	89.3	27.8	50.9	50.0		31.7		37.1
256										
257	1:3.8	963.7	353.3	170.1	68.3				154.2	217.8
258	1:2.6	247.5	60.5							187.0
259	1:2.7	261.4	74.5	29.5					47.2	60.0
260	1:1.9	115.6							1129.7	115.6
261	1:2.0	218.9	200.0	50.3						-31.4
262	1:1.4	51.4								51.4
263	1:2.5	122.6	24.9			35.0				62.7
264	1:1.5	194.9	116.9							
265	1:2.4	664.2	137.2	130.0	44.9	115.4			11161.2	236.7
266	1:1.4	81.4	5.1		32.6	5.0				38.7
267	1:3.3	1,201.4	217.6		465.8	188.0		67.4	*125.8	206.5
268	1:2.6	168.8							1124.5	
269	1:1.9	1,603.2	127.2		444.3	425.0		100.0	11506.7	506.7
270	1:1.5	925.6	275.1						11213.4	
271	1:2.5	150.4	19.9					t8.2	1150.9	122.3
272	1:2.1	297.9	25.3		98.2	68.0				106.4
273	1:2.0	14,273.6	2,346.6	228.0	98.9	3,669.0		1,208.0	116,088.6	6,723.1
274	1:1.7	1,755.5						750.0	517.8	487.7
275	1:3.7	490.0	41.4	7.0	203.8	54.3		t120.2	43.0	20.3
276	1:1.9	398.7	13.2	26.9		20.0		t168.4	96.5	73.7
277	1:2.5	135.2	15.4		86.0	25.0		t8.8	1136.0	
278					382.8				1195.4	
279	1:1.5	81.9	17.2		25.0				39.7	
280										

# Ratio of expenses (Col. 17) to revenue (Col. 10).

† Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
281. Manitowoc, Wis.	81.6	35.0	55.3	2.6	174.5		46.1
282. Marinette, Wis.	75.3	25.5	23.5	30.7	155.0		
283. Marshalltown, Iowa					224.1		
284. Mason City, Iowa						3.1	29.1
285. Massillon, Ohio	338.6	75.7	24.2	8.3	446.8		
286. McKinney, Tex. <sup>2/88</sup>					170.5		
287. Meadville, Pa.	74.4	21.9	32.2		128.5		
288. Medford, Ore. <sup>7/88</sup>				0.5	351.8	4.0	34.3
289. Memphis, Tenn.	1,977.1	1,737.2		39.5	3,753.8		
290. Menasha, Wis.	57.2	12.1	71.4	2.4	143.1		27.3
291. Meriden, Conn.							
292. Merrick, N.Y.*	†	1,071.1	1.2	0.7	*1,137.1	10.3	74.9
293. Mesa, Ariz. <sup>7/88</sup>					5,805.0		
294. M.W.D. So. Calif. <sup>7/88*</sup>					*4,369.4	82.7	82.7
295. Miami, Fla. <sup>7/88</sup>	2,127.1	1,032.6	†				
296. Michigan City, Ind.	†	207.8	115.6	4.6	328.0		37.0
297. Middletown, Conn.	†	200.4	28.5	0.4	229.3		
298. Midland, Mich. <sup>7/88</sup>					665.1		17.0
299. Milford, Mass.	106.2	21.9	5.1		133.2	3.2	11.2
300. Milwaukee, Wis.	1,530.4	670.9	1,771.0	27.0	*4,540.0	111.8	309.7
301. Minneapolis, Minn.	3,538.2	802.3	†	3.5	4,344.0	101.0	
302. Mishawaka, Ind.				0.6	209.6		
303. Missoula, Mont.							
304. Mobile, Ala.					2,209.8		
305. Modesto, Calif. <sup>7/88</sup>					328.8		
306. Monroe, Mich. <sup>7/88</sup>					264.5		36.0
307. Monroe, N.C. <sup>7/88</sup>	95.2	28.8	6.2		130.2		
308. Monterey Park, Calif. <sup>7/88</sup>	282.0	31.3			313.3		
309. Moorhead, Minn.					130.8	1.4	14.7
310. Mount Vernon, N.Y.				7.1	537.2		
311. Murfreesboro, Tenn.					250.0		
312. Nacogdoches, Tex. <sup>4/88</sup>	103.8	32.5	16.0		152.3		
313. Nashua, N.H.					279.8	5.8	49.2
314. Nashville, Tenn.					2,098.6		138.4
315. Natick, Mass.					152.0		
316. Naugatuck, Conn.	†	128.8	145.4	7.6	281.8		21.1
317. Neenah, Wis.	83.2	19.5	38.2	1.9	142.8	4.8	37.3
318. New Albany, Ind.	338.1	120.5	36.6	4.4	499.6	30.2	25.9
319. New Bedford, Mass.	208.0	117.2	133.3		458.5	8.7	
320. New Haven, Conn.	†	2,762.8	614.2	31.3	3,408.3	106.4	200.9

\* See notes beginning on p. 694.

† Included in "Coml."

Financial Analysis, 1959

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.\$						\$1,000	\$/cap.\$
281	5.8	226.4	7.55	none	70.5	8.2	0.2	1.2	80.1	2.67
282	1.6	156.6	11.19		73.2	‡	8.7		81.9	5.85
283										
284	92.4	316.5	9.89	26.0	147.0	‡		95.1	242.1	7.57
285	4.9	483.9	12.73	none	154.6	35.7	115.8		306.1	8.05
286		170.5	11.37		83.2	‡			83.2	5.55
287		128.5	6.43	8.7					129.7	6.49
288	21.6	411.7	18.71		92.8	21.8	3.9		118.5	5.39
289	95.1	3,848.9	7.70	112.0	1,349.1	935.3			2,284.4	4.57
290	0.1	170.5	11.37	none	102.5	‡	15.4		117.9	7.86
291		252.5	6.02							
292	13.2	1,235.5	7.97	none	362.7	49.7	445.9		858.3	5.54
293										
294										
295		4,534.8	14.25		1,643.7	348.2			1,991.9	6.26
296	18.4	383.4	12.37	none	122.7	84.3	6.0		213.0	6.87
297	7.9	237.2	9.48	4.6	133.2	‡			133.2	5.32
298	47.7	729.8	33.17		229.6	27.4		5.9	262.9	11.95
299	3.8	151.4	10.10	2.0	63.9	10.5	48.5		122.9	8.20
300	9.4	4,970.9	7.11	none	2,525.7	672.5		58.0	3,256.2	4.66
301	236.7	4,681.7	8.67		3,166.6	‡		174.2	3,340.8	6.19
302	12.8	222.4	6.75	11.8	113.6	35.8	2.1	8.3	159.8	4.85
303										
304	131.8	2,341.6	14.64						1,296.7	8.10
305	50.2	379.0	12.63		144.3	‡			144.3	4.81
306	8.0	308.5	12.34		110.9	16.6		65.8	193.3	7.73
307	9.9	140.1	11.67	4.8	28.7	53.4			82.1	6.84
308		313.3	10.44	10.0	98.7	90.7			189.4	6.31
309	38.0	184.9	9.24		56.4	15.3			71.7	3.58
310	8.4	545.6	7.27	38.5	54.1	411.1			465.2	6.20
311		250.0	14.70							
312	11.1	163.4	10.89	none	81.3	‡			81.3	5.42
313	11.3	346.1	9.89	none	77.4	18.5	133.3	0.1	229.3	6.55
314		2,237.0	9.56	none					796.9	3.41
315	20.0	172.0	6.37	4.2	66.5	27.9		33.3	127.7	4.73
316	2.7	305.6	16.09	none	101.5	28.6	78.2		207.3	10.92
317		184.9	12.32							
318		555.7	13.89	none	164.3	54.0	160.9		379.2	9.48
319	22.0	489.2	3.94		122.5	261.0			383.5	3.09
320	27.1	3,742.7	12.40	none	1,243.7	92.6	1,246.9	20.7	2,603.9	8.63

‡ Included in preceding column.  
§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earn- ings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
281	0.1	112.6				112.6	1,858	62			
282	5.6										
283											
284		38.3				38.3	982	31	127	63	none
285	24.0										
286							\$549	\$37			95
287		15.3				15.3	680	34	112	155	none
288	0.9	183.3				183.3	4,995	227	none	83	2,650
289						2,058.6	34,675	69	117,985	1,206	8,511
290	9.0	61.7				61.7	1,139	76	342	541	none
291											
292	36.1						6,226	40	11613		
293											
294							315,340				202,824
295				2,067.4		2,067.4	\$32,348	\$102	1,615	none	26,445
296	1.6	120.9				120.9	2,619	85	504	262	913
297		113.6				113.6	2,099	84	161	350	710
298		79.6	187.8		†215.0	482.4	8,345	379	24	248	4,795
299		27.8			10.0	37.8	561	37	312	168	120
300	32.0	2,595.5				2,595.5	52,338	75	10,923	none	2,338
301		302.6				302.6	26,715	50		2,775	7,830
302	1.0	37.6				37.6	\$1,318	\$40	277	19	none
303											
304											
305		150.8				150.8					
306		105.3				105.3	3,296	132			2,055
307		28.1	466.4			495.4	1,572	131		12	692
308		55.0				55.0	2,250	75		28	
309		130.5				130.5	1,194	60	376	834	410
310		50.0	50.0			100.0	3,754	50			432
311											
312		37.2				37.2	1,198	80	194	70	455
313	38.6		*75.0		60.0	135.0	2,132	61	516	none	438
314		485.6	127.8			613.4	20,306	87	1,874	none	
315		53.2		34.2		87.4	1,904	71	none	140	222
316	25.6		292.0			292.0	2,102	111	626	341	492
317											
318	29.0					130.8	2,013	50			
319		39.9	43.0			83.9	8,174	66	none	none	404
320	33.3	580.0			297.0	*3,045.0	16,581	55	7,259		7,000

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
281	1:2.8	146.3						t30.8	1125.8	115.5
282	1:1.9	74.7						t15.0	11.1	
283										
284	1:1.4	74.4			38.3				30.9	5.2
285	1:1.6	177.8							27.5	
286	1:2.0	87.3			12.6					74.7
287	1:1.0	-1.2								
288	1:3.5	293.2	56.6		84.3	45.0			1115.4	107.3
289	1:1.7	1,564.5	212.5	4.9	66.7	560.2		4.5	715.7	
290	1:1.4	52.6			37.6			15.0	115.9	
291										
292	1:1.4	377.2								
293										
294										
295	1:2.3	2,542.9	650.2	102.5		625.0		336.4	524.1	304.7
296	1:1.8	170.4	28.5			32.0			67.3	42.6
297	1:1.8	104.0	13.4		29.5	58.0			1149.1	3.1
298	1:2.8	466.9	101.9	6.7	79.6	183.0			3.8	91.9
299	1:1.2	28.5	4.8				22.0		118.5	1.7
300	1:1.5	1,714.7	22.0	18.4	456.5			t700.0	11517.8	517.8
301	1:1.4	1,340.9	173.1			482.0			11498.5	685.8
302	1:1.4	62.6			37.6				1121.6	25.0
303										
304	1:1.8	1,044.9								
305	1:2.6	234.7	4.6		150.8	11.2		68.1		
306	1:1.6	115.2						x52.7	62.5	
307	1:1.7	58.0			5.3	41.0				11.7
308	1:1.7	123.9			55.0			t40.5		28.4
309	1:2.6	113.2	8.0	6.5	70.0	20.0			1133.7	8.7
310	1:1.2	80.4	8.0	3.0				84.9		
311										
312	1:2.0	82.1	9.8	4.9	37.2	12.7			1128.5	17.5
313	1:1.5	116.8	14.9			2.0	49.0		1131.3	50.9
314	1:2.8	1,440.1	138.5		451.4	311.0		539.2	11131.9	
315	1:1.3	44.3	5.0			28.3				11.0
316	1:1.5	98.3	20.7			5.0	35.0		1131.0	37.6
317										
318	1:1.5	176.5							1145.1	
319	1:1.3	105.7	8.8		39.9	70.0		68.0		
320	1:1.4	1,138.8	245.6		225.0	23.0	480.0		11348.4	

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
321. New Iberia, La.*	440.1	144.2			584.3		20.0
322. New Orleans, La.					3,502.8		
323. New Rochelle, N.Y.	†	1,578.1	157.5	14.6	1,750.1	31.0	183.2
324. New York, N.Y.							
325. Newport Beach, Calif. <sup>7/88</sup>					268.4		
326. Newport News, Va.*	1,090.6	546.3	15.7		1,652.6		86.8
327. Newton, Iowa	110.0	15.0	45.0		170.0		22.0
328. Newton, Kan.					200.3		
329. Niagara Falls, N.Y.	†	445.6	792.1		1,237.7		
330. Niles, Ohio	†	160.3	128.2		288.5		
331. Norfolk, Neb.					76.5		
332. Norfolk, Va.					3,285.6		24.8
333. North Miami, Fla.					483.7		
334. North Platte, Neb.					131.7		
335. Norwich, Conn.	†	203.7	65.7	5.0	274.4	12.0	42.4
336. Oak Park, Ill.							
337. Oak Ridge, Tenn.							
338. Ocala, Fla. <sup>10/88</sup>					215.7		11.0
339. Oceanside, Calif. <sup>7/84</sup>					205.1		
340. Oklahoma City, Okla. <sup>7/88</sup>	†	4,313.3	9.4		4,322.7		
341. Olean, N.Y. <sup>8/88</sup>	158.8		75.2	0.8	234.8		
342. Omaha, Neb.	†	1,817.9	1,160.8	37.8	3,016.5		222.6
343. Oneonta, N.Y.					128.4		1.3
344. Ontario, Calif.							
345. Orange, Calif. <sup>7/88</sup>					250.0		
346. Orlando, Fla.					974.3	†	22.2
347. Oskaloosa, Iowa	90.2	26.6	7.4		124.2		
348. Ossining, N.Y.				1.6	187.8		
349. Ottawa, Kan.	60.5	42.4	†	0.1	103.0		10.2
350. Ottumwa, Iowa	225.5	52.7	120.6	1.5	400.3		
351. Owatonna, Minn. <sup>8/88</sup>	57.4	36.3	†		93.7	2.9	3.8
352. Oxnard, Calif. <sup>8/88</sup>					291.8		5.6
353. Painesville, Ohio					241.9		
354. Palo Alto, Calif. <sup>7/88</sup>					876.7	27.0	19.2
355. Paris, Tex. <sup>7/88</sup>					231.6		
356. Pasadena, Calif. <sup>7/88</sup>				12.9	2,019.6	98.5	3.0
357. Pasco, Wash.				0.3	252.7	7.0	2.1
358. Passaic Val. Com., N.J.*					3,571.7	34.5	139.0
359. Peekskill, N.Y.					227.4		
360. Pendleton, Ore. <sup>7/88</sup>	125.0	25.0			150.0		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
Revenue (contd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	\$/cap.‡						\$1,000	\$/cap.‡	
321	10.6	614.9	10.25	8.0	7.0	23.8		8.3		
322		3,502.8	5.58		2,302.8	‡			2,302.8	3.67
323	7.1	1,971.4	14.19	none	901.1	112.5	441.0		1,454.6	10.46
324		46,397.5	6.06						15,794.8	2.06
325		268.4	13.42		136.0	56.7		7.3	200.0	10.00
326	160.4	1,899.8	9.50		653.1	‡	76.0	34.8	763.9	3.82
327		192.0	13.71		88.0	25.0			113.0	8.06
328	2.5	202.8	15.61						84.5	6.50
329		1,237.7	10.31	none	628.0	‡			628.0	5.23
330		288.5	13.74	0.5	172.4	27.9			200.3	9.54
331		76.5	5.88							
332	62.5	3,372.9	9.50						1,224.3	3.45
333	79.5	563.2	13.10		248.1	‡			248.1	5.77
334	35.1	166.8	10.43	7.8	55.0	44.2			99.2	6.20
335	4.3	333.1	9.00	none	85.1	25.3	2.9		113.3	3.06
336										
337										
338	14.9	241.6	17.27	none	98.5	31.8			130.3	9.31
339	14.6	219.7	9.57						135.7	5.92
340		4,322.7	14.46	120.5	864.3	607.1			1,471.4	4.92
341	0.1	234.9	10.21	18.0	134.9	‡	0.2		135.1	5.87
342	110.9	3,350.0	11.55	63.7	1,577.2	445.5		12.4	2,035.1	7.01
343	8.0	137.7	6.89	4.5	39.2	38.9			78.1	3.91
344										
345	1.8	251.8	12.59							
346	100.3	1,096.8	10.45	none	535.5	‡			535.5	5.10
347	12.6	136.8	11.40		70.8	6.0	2.1	3.6	82.5	6.87
348	17.2	205.0	12.81	24.2	133.7	‡	5.1	4.4	143.2	8.95
349		113.2	10.29							
350	21.8	422.1	12.05	43.3	198.0	74.3			272.3	7.77
351	3.6	104.0	8.67	0.2	33.0	13.2		0.4	46.6	3.89
352	40.7	338.1	11.66						94.4	3.26
353	14.9	256.8	16.05	1.5	121.5	32.6			154.1	9.63
354	154.5	1,077.4	21.98	none	256.0	178.3			434.3	8.87
355	43.8	275.4	11.47						164.6	6.86
356		2,121.1	15.95		1,182.7	‡	8.5		1,191.2	8.96
357	70.8	332.6	23.75	none	76.3	12.0	7.3		95.6	6.83
358	46.5	3,791.7	13.35	none	1,474.1	374.4	29.4		1,877.9	6.61
359	12.5	239.9	10.90						240.8	10.94
360		150.0	10.71		89.0	5.0			94.0	6.71

‡ Included in preceding column.

§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depreciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23	\$1,000	\$/cap.§			
321							3,255	54	736		
322						1,503.4	43,150	69			
323	22.4					556.1	9,763	70	1,943	721	6,226
324											
325		61.5				61.5					
326	4.0	275.2	1,167.5			1,442.7	10,486	52	2,859	8,468	3,700
327		32.0		550.0		582.0	2,143	153	485		550
328		82.2				82.2					
329			577.8			577.8	11,642	97	2,307		7,610
330							2,600	123	none	none	none
331		25.0				25.0	1,225	94			
332				204.1		204.1	27,942	79			12,500
333				276.6		276.6	2,326	54	11,427	759	767
334		0.5		27.3		27.8	980	61	42	807	120
335	0.9				40.0	40.0	2,170	59	1,186	1,735	363
336											
337											
338						none	1,177	84	none	826	351
339						36.2	1,140	50			317
340						545.3					
341	0.1	12.2				12.2	1,116	49	348	none	none
342		1,790.1		3,649.9		5,440.0	19,120	66	none	6,120	9,350
343							1,200	60		44	none
344											none
345											
346		483.1				483.1	6,768	64			
347	1.5	22.4				22.4	674	56	317	15	100
348	2.5	12.6	6.9			19.5	11,212	176	none	none	205
349											
350						none	12,365	168			
351		97.2				97.2	606	51	486		
352		235.6				235.6	1,854	64		153	180
353				81.4		81.4	3,715	232			
354							3,373	69	11,700	96	61
355							3,959	165			470
356	0.4	554.1				554.1	9,007	68	11,420	11,136	none
357	2.2	151.4		4.6		156.0	13,018	1217	none	none	1,006
358	0.8	436.1				436.1	135,419	1125	17,674	764	16,917
359						6.8	1,402	64		112	
360											

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
321										
322	1:1.5	1,200.0								
323	1:1.4	516.8	213.0	60.5					103.8	139.5
324	1:2.9	30,602.7	¶			¶39,707.6				
325	1:1.3	68.4								
326	1:2.5	1,135.9	118.4			239.5		375.0	11205.2	403.0
327	1:1.7	79.0	11.0	31.7	30.0	35.0			1136.0	
328	1:2.4	118.3		51.8	66.5					
329	1:2.0	609.7		350.0				1105.0	1175.0	154.7
330	1:1.4	88.2			55.8				0.3	32.1
331										
332	1:2.8	2,148.6	311.9	0.6		712.0		1,124.0		
333	1:2.3	315.1	22.4			21.0			1170.0	271.7
334	1:1.7	67.6	1.8		41.8	10.0			112.6	14.0
335	1:2.9	219.8	14.9		32.3	53.0		82.6	37.0	
336										
337										
338	1:1.9	111.3	15.1	18.9	49.0	17.0				
339	1:1.6	84.0								
340	1:2.9	2,851.3								
341	1:1.7	99.8			12.2			s71.6	118.0	16.0
342	1:1.6	1,314.9	180.9		783.2			69.0	11296.3	281.8
343	1:1.8	59.6		44.0		10.0		t5.6		
344										
345										
346	1:2.0	561.3							11241.4	
347	1:1.7	54.3	2.1	1.8	22.4	20.0			1118.0	8.0
348	1:1.4	61.8	9.2	4.8	19.5	15.0		4.8		8.5
349										
350	1:1.6	149.8	9.1	116.1	24.6					
351	1:2.2	57.4							1117.2	57.4
352	1:3.6	243.7		1.0		17.0		40.0		52.8
353	1:1.7	102.7	8.2	8.1	57.1	24.0				5.3
354	1:2.5	643.1	16.9		278.8	44.0		t253.0	1164.1	50.2
355	1:1.7	110.8	13.5		59.9	20.0		17.4		
356	1:1.8	929.9			402.6			d527.3	11262.3	
357	1:3.5	237.0	19.2	29.2	151.4	16.0		t5.9	1187.5	15.3
358	1:2.0	1,913.8	722.2		287.2	797.5				106.9
359	1:1.0	-0.9								
360	1:1.6	56.0								

# Ratio of expenses (Col. 17) to revenue (Col. 10).

¶ Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
361. Phenix City, Ala.					212.4		
362. Philadelphia, Pa.					12,495.6	146.0	618.7
363. Phila. Sub. Wtr. Co., Pa.*	5,575.6	549.6	393.8	38.3	6,557.3	88.0	183.5
364. Phoenix, Ariz. <sup>7/55</sup>					3,460.6		
365. Pittsburg, Calif. <sup>7/55</sup>							
366. Pittsburg, Kan.					238.4	2.5	
367. Pittsburgh, Pa.	3,650.5	1,603.3	1,487.0		6,740.8		
368. Pomona, Calif. <sup>7/55</sup>					739.8	28.0	
369. Pontiac, Mich.							
370. Poplar Bluff, Mo.	76.7	37.3			114.0		
371. Portland, Me.	682.0	240.4	118.8	27.1	1,068.3		87.4
372. Portland, Ore. <sup>7/55</sup>					3,645.0	77.7	
373. Portsmouth, Va. <sup>7/55</sup>					1,010.8		66.5
374. Prichard, Ala.	†	285.8	9.6	6.1	301.5		
375. Providence, R.I. <sup>10/54</sup>	1,105.7	342.4	750.0	49.3	2,247.4		73.7
376. Puerto Rico A.S.A. <sup>7/55*</sup>	3,791.0	1,082.7	394.8		5,268.5	1,686.8	
377. Queens County, N.Y.*	†	466.0	14.0	4.0	484.0	5.9	68.2
378. Racine, Wis.	307.4	92.0	215.0	13.3	627.7	28.9	117.2
379. Rahway, N.J.	†	159.5	168.0		327.5		
380. Reno, Nev.	544.6	242.6	*14.5		801.7		14.8
381. Richmond, Va. <sup>7/55</sup>					2,064.0	43.3	299.5
382. Ridgewood, N.J.					407.1		28.2
383. Roanoke, Va.	740.0	240.0	85.0	0.4	1,065.4	10.0	23.0
384. Robbinsdale, Minn.					55.4		
385. Rochester, N.H.	†	66.9	7.8		74.7		0.2
386. Rochester, N.Y.*	†	705.6	244.8	9.3	*1,355.9	8.4	82.4
387. Rome, N.Y.	170.1		120.2		290.3		
388. Sacramento, Calif.					1,125.8		
389. St. Charles, Mo. <sup>4/55</sup>					188.1		
390. St. Cloud, Minn.	150.0		20.0		170.0		52.0
391. St. Louis, Mo. <sup>9/54</sup>	2,280.3	2,930.3	†	8.1	5,218.7	122.7	
392. St. Louis County, Mo.	3,214.9	563.3	346.9	92.0	*4,372.0	19.7	169.3
393. St. Louis Park, Minn.					301.6		
394. St. Paul, Minn.				22.7	2,459.6		27.9
395. Salem, Ohio	†	141.9	41.0		182.9		
396. Salem, Ore. <sup>7/55</sup>	265.9	135.8	51.9	4.7	458.3		
397. Salina, Kan.					465.3		
398. Salisbury, Md.	102.0		101.0		203.0		
399. Salt Lake City, Utah					2,042.3		
400. San Angelo, Tex. <sup>10/54</sup>					1,215.0		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
Revenue (contd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	\$/cap.‡						\$1,000	\$/cap.‡	
361	16.2	228.6	9.53		136.9	‡		1.1	138.0	5.75
362	335.4	13,595.7	6.18		7,433.8	1,998.2			9,432.0	4.29
363	92.5	6,921.3	12.47		2,125.0	581.1	1,291.9		3,998.0	7.20
364		3,460.6	16.03		1,300.2	‡	34.1		1,334.3	6.18
365		215.0	12.65		52.3	94.7			147.0	8.65
366	5.9	246.8	11.75	none	99.5	48.4	4.0	0.6	152.5	7.26
367	469.6	7,210.4	11.10	508.2	4,303.0	‡			4,303.0	6.62
368	9.3	777.1	15.24		191.0	300.9	0.9		492.8	9.67
369										
370	4.9	118.9	6.99	4.5	25.5	16.2		29.1	70.8	4.17
371	37.7	1,193.4	9.04	none	333.5	156.5	18.3		508.3	3.85
372		3,722.7	9.31	45.6	1,830.8	‡			1,830.8	4.58
373	37.6	1,114.9	7.43	none	313.1	59.4			372.5	2.48
374		301.5	6.56		97.4	26.7	5.4		129.5	2.82
375	224.1	2,545.2	7.51	none	763.7	‡		40.4	804.1	2.37
376	42.6	6,997.9	5.38	none	2,357.8	810.9	4.1	20.0	3,192.8	2.46
377	0.4	558.5	4.30	none	233.2	29.9	184.9		448.0	3.45
378	39.1	812.9	10.16	none	342.4	116.2			458.6	5.73
379		327.5	14.24	69.2	228.9	‡			228.9	9.95
380	3.6	820.1	14.91	none	211.4	75.6	206.8		493.8	8.97
381	79.5	2,486.3	10.36	none	712.0	312.6		13.5	1,038.1	4.32
382	86.7	522.0	10.04	none	227.0	‡			227.0	4.37
383	129.2	1,227.6	12.02	63.0	317.9	90.5			408.4	4.00
384	8.8	64.2	4.59		48.6	‡			48.6	3.48
385	12.4	87.3	5.82		28.6	15.7	0.5		44.8	2.99
386	22.4	1,469.1	13.61	0.2	695.8	57.0	392.1		1,144.9	10.61
387	24.9	315.2	7.16		64.0	67.9	27.8		159.7	3.63
388	39.0	1,164.8	7.15		670.0	‡	2.1		672.1	4.12
389		188.1	8.95							
390		222.0	7.41	5.5	72.0	43.0		5.0	120.0	4.00
391	49.3	5,390.7	6.07	1,347.7	5,271.5	‡			5,271.5	5.94
392	3.2	4,564.2	9.10	2,000.0	1,392.7	246.1	1,123.0		2,761.8	5.51
393		301.6	7.94	4.5	136.3	‡			136.3	3.59
394	146.0	2,633.5	7.77		1,724.9	‡		300.4	2,025.3	6.98
395		182.9	13.07	11.2	59.9	31.3			91.2	3.52
396	52.4	510.7	12.17	23.7	117.6	61.3			178.9	4.27
397	39.1	504.4	14.83	82.7	207.0	‡			207.0	6.08
398	9.0	212.0	12.47		64.7	67.0			131.7	7.75
399		2,042.3	8.27	78.2					729.0	2.95
400		1,215.0	18.70		634.2	71.9			706.1	10.87

† Included in preceding column.

‡ Population served at retail.

TABLE 4—Part II (contd.)

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
361		57.0				57.0	1,748	73	11208	869	1,150
362			9,601.4			9,601.4					
363	18.7					8,764.5	160,872	1110	3,866	none	28,225
364	1.0					1,379.3	28,393	131	none	none	17,092
365						none	1,625	96			
366	1.6	784.0				784.0	1,931	92			
367		298.7				298.7	20,981	32	18,509	none	275
368	0.1			351.6		351.6	5,313	104	1,142		1,582
369											
370		30.3				30.3	693	58	265	377	130
371	1.5	374.8		1,200.0		1,574.8	18,105	137	3,234	1167	12,649
372						none	31,673	79	none	none	9,520
373		346.6				346.6	12,976	87	112,819	none	507
374	1.8	130.0				130.0	1,134	25	27	30	288
375							56,209	166	945	10,468	15,000
376	0.1	1,982.1			1,721.6	*8,450.4	*74,429		104	5,995	19,631
377	33.1					1,772	1,772	14	11526		
378		500.3				500.3	5,128	64	none	none	123
379						46.2					
380	25.2					438.4	5,517	100	627		
381		10.5	258.3			268.8	12,331	51	6,546	2,759	9,066
382		218.0		134.7		352.7	5,596	108		70	2,625
383				452.7		452.7	12,320	121	528	264	7,893
384							269	19		53	
385	0.6						1,450	97	389	154	635
386	26.7						5,036	47	11,503		
387	8.8	3.1				3.1				152	41
388	0.2					251.4	12,003	74			
389											
390			3,000.0			3,000.0					
391							57,833	65	none		none
392	24.6	1,534.4		*4,700.0	600.0	6,834.4	39,883	80	4,514	1,713	19,803
393		64.6				64.6	1,958	51		145	310
394		452.5		949.1		1,401.6	27,856	82		23,761	
395		14.4				14.4	1,703	122	none	19	1,464
396		150.2				150.2	3,679	88		106	1,620
397				400.0		400.0	3,309	97		100	1,534
398							2,000	118			505
399		329.4				329.4	20,872	85			1,660
400		70.5		614.2		684.7	5,978	92	758	991	6,943

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
361	1:1.7	90.6	34.9		55.7					
362	1:1.4	4,163.7	1,033.6	1,822.3	463.0					844.8
363	1:1.7	2,923.3	944.5							237.9
364	1:2.6	2,126.3	432.4		673.0	761.0	1,740.9	259.9	11307.6	
365	1:1.5	68.0						50.0	11972.6	
366	1:1.6	94.3		27.7		14.0			52.6	
367	1:1.7	2,907.4	15.1		58.1	163.3		1,000.0	11741.9	1,670.9
368	1:1.6	284.3	45.7	48.0	111.6	79.0			11122.2	
369										
370	1:1.7	48.1	2.7	15.2	11.8				18.4	
371	1:2.4	685.1	296.0	122.1					11246.6	267.0
372	1:2.0	1,891.9	232.3	450.0		450.0		t207.0	11512.1	552.6
373	1:3.0	742.4	0.6	100.0	200.8	1.0		440.0	11125.5	
374	1:2.3	172.0	10.4	16.2	130.0	9.0			6.4	
375	1:3.2	1,741.1	610.0	310.1	415.6			t225.4	180.0	
376	1:2.2	3,805.1	682.7	535.0	570.8	562.3		x41.5	892.0	520.8
377	1:1.2	110.5								
378	1:1.8	354.3	8.1		231.1			t115.1	1166.6	
379	1:1.4	98.6	3.0		47.3			2.6		29.0
380	1:1.7	326.3								
381	1:2.4	1,448.2	230.7	503.7				t510.9	11523.5	202.9
382	1:2.3	295.0	23.1		218.9	53.0				
383	1:3.0	819.2	166.2		178.6	339.2			135.2	
384	1:1.3	15.6							1113.0	
385	1:1.9	42.5	16.0						1115.1	11.4
386	1:1.3	324.2								
387	1:2.0	155.5	0.6		31.3	8.0				
388	1:1.7	492.7	53.2		251.4	167.6		t115.0	0.6	
389								x20.5		
390	1:1.9	102.0								
391	1:1.0	119.2								
392	1:1.7	1,802.4	574.5				75.4		11514.9	1,152.5
393	1:2.2	165.3		53.8	64.6					46.9
394	1:1.3	608.2	91.6	208.8		224.0				
395	1:2.0	91.7	39.9	1.6	7.2	43.0				
396	1:2.9	331.8	55.5		180.2	74.0				
397	1:2.4	297.4	36.0	100.0	81.4	66.0			1192.2	22.1
398	1:1.6	80.3	16.3			64.0			24.0	
399	1:2.8	1,313.3	65.6	122.0	329.4					
400	1:1.7	508.9	181.4	366.9	687.5	182.0		1,246.1		
									6.7	

# Ratio of expenses (Col. 17) to revenue (Col. 10).

† Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
401. San Antonio, Tex.				17.1	3,890.7		
402. San Bernardino, Calif. <sup>7/88</sup>	1,158.4			1.7	1,160.1		
403. San Francisco, Calif. <sup>7/88</sup>	4,651.1	4,482.3	†		*12,986.7	542.0	259.7
404. Sandusky, Ohio	†	288.7	80.4		369.1		
405. Sanford, Fla. <sup>10/88</sup>					186.6		
406. Sanford, N.C. <sup>7/88</sup>					85.0		
407. Santa Barbara, Calif. <sup>7/88</sup>	662.0		0.9	6.0	668.9		
408. Santa Cruz, Calif. <sup>7/88</sup>	312.8	10.8	66.4	1.1	391.1		0.7
409. Santa Fe, N.M.	318.5	210.6		0.2	529.3	2.1	4.6
410. Santa Paula, Calif.	†	130.9	35.2	0.1	166.2	1.0	2.7
411. Santa Rosa, Calif. <sup>7/88</sup>					454.3		
412. Schenectady, N.Y.							
413. Scottsbluff, Neb.					121.2		
414. Scranton, Pa.*	3,558.3	712.3	884.2	88.3	5,243.1	50.8	84.6
415. Seattle, Wash.					3,875.9	8.9	48.0
416. Shamokin, Pa.*	329.5	35.0	75.5	5.0	*500.0		17.2
417. Sharon, Pa.*	462.3	107.9	222.4	4.0	796.6		28.3
418. Shawnee, Okla. <sup>7/88</sup>							
419. Sheboygan, Wis.	165.0	47.1	84.1	5.3	301.5	11.9	73.8
420. Sheffield, Ala. <sup>8/88</sup>	92.8	54.4	15.6	13.0	175.8		
421. Shelbyville, Ind.	88.2	34.8	37.2	4.0	164.2	4.1	13.4
422. Sheridan, Wyo.	67.8	17.2	2.6		*100.1		
423. Shorewood, Wis.					131.6	0.4	12.9
424. Shreveport, La.	1,110.4	279.1	407.6	1.0	1,798.1		
425. Sioux City, Iowa					492.0		
426. Sioux Falls, S.D.					565.0		
427. Snyder, Tex. <sup>10/88</sup>	199.6	37.4	12.5		249.5		
428. South Gate, Calif. <sup>7/88</sup>	301.2	39.5	62.6	51.7	455.0	3.1	6.1
429. South Milwaukee, Wis.	55.6	7.7	57.0		120.3	4.4	27.6
430. South Orange, N.J.					190.2	25.0	
431. South St. Paul, Minn. <sup>4/88</sup>	84.9	9.9	0.8		95.6		
432. So. Calif. Water Co.*	†	3,413.6	272.4	10.4	3,696.4	92.0	90.0
433. Spokane, Wash.	643.8	488.0	†	3.1	1,134.9	56.2	
434. Springfield, Ill. <sup>9/88</sup>							
435. Springfield, Mass.					1,589.4		
436. Springfield, Mo.	739.0	341.5	57.9	1.3	1,217.4		77.8
437. Stamford, Conn.	†	711.9	143.4	13.5	868.8	15.1	65.6
438. Sterling, Ill.	182.2	37.6	37.0	3.9	260.7	4.8	14.2
439. Stevens Point, Wis.	74.4	28.2	13.1	2.8	118.5		31.2
440. Struthers, Ohio	134.2	11.7	8.1		154.0	1.6	8.9

\* See notes beginning on p. 694.

† Included in "Coml."

# Financial Analysis, 1955

683

1	9	10	11	12	13	14	15	16	17	18
Revenue (contd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	/cap.\$						\$1,000	/cap.\$	
401	66.5	3,957.2	8.51	669.5	1,280.9	752.7			2,033.6	4.37
402	1.3	1,161.4	13.52	29.1	305.1	60.6			441.5	5.15
403	379.6	14,168.0	17.93	740.0	3,811.0	1,118.4	1.0	74.9	6,088.9	7.71
404	49.9	419.0	12.69	7.4	230.7	†	713.5	446.0	230.7	6.99
405		186.6	9.33		124.7	†			124.7	6.24
406		85.0	5.67		76.7	†			76.7	5.12
407	119.2	788.1	12.13	none	103.5	233.0			336.5	5.18
408	0.6	392.4	14.01		118.9	33.0	2.2	31.3	185.4	6.62
409	12.5	548.5	16.63	none	160.3	19.1	130.6		310.0	9.38
410	4.3	174.2	12.44	none	70.2	17.1	35.2		122.5	8.75
411		454.3	12.28	6.0	164.5	60.8			225.3	6.09
412		617.3	5.51							
413	3.5	124.7	8.91	14.2	54.9	4.6	0.8		60.3	4.31
414	120.0	5,498.5	10.58	none	1,047.1	370.8	1,259.5		2,677.4	5.15
415	18.5	3,951.3	6.59	259.2	1,975.5	†	100.1		2,075.6	3.46
416	2.7	519.9	10.20	none	202.6	60.0	69.9	31.4	363.9	7.14
417	8.4	833.3	15.14	none	347.0	33.4	134.6		515.0	9.36
418		440.1	14.67						159.9	5.33
419	3.4	390.6	8.68	none	175.7	48.8	0.4		224.9	5.00
420	9.8	185.6	12.38	none	74.8	†		40.6	115.4	7.70
421		181.7	13.98	none	54.8	10.8	54.0		119.6	9.20
422	2.1	102.2	6.82	19.1	41.2	26.0			67.2	4.49
423	0.3	145.2	8.54		129.3	†			129.3	7.61
424	8.6	1,806.7	10.04		622.0	193.4			815.4	4.53
425		492.0	5.19	61.6	388.7	†	12.6		401.3	4.23
426		565.0	9.42							
427	7.8	257.3	15.13	45.7	52.4	19.3			71.7	4.22
428	29.9	494.1	12.35	none	162.6	33.3			195.9	4.90
429	5.1	157.4	10.49	none	101.4	†			101.4	6.76
430		215.2	12.67		60.8	59.6			120.4	7.09
431	23.6	119.2	6.28	19.5	49.4	21.0		11.8	82.2	4.33
432	42.0	3,920.4	13.85	none	1,386.5	227.9	833.4	10.4	2,458.2	8.68
433	3.4	1,194.5	6.46	none	419.9	223.2	51.7		694.8	3.76
434		1,039.4	9.45	136.1	419.3	137.0		4.6	560.9	5.10
435	506.6	2,095.0	12.03	130.8	858.0	55.0		5.0	918.0	5.27
436	14.4	1,309.6	14.88		334.9	74.8	232.5		642.2	7.30
437	83.9	1,033.4	14.76		295.4	36.3	359.7		691.4	9.88
438	2.0	281.7	10.84	0.2	85.3	22.9	81.2		189.4	7.29
439	1.9	151.6	9.47	none	50.7	17.2			67.9	4.24
440	5.2	169.7	6.53	none	85.0	8.6	35.4	0.1	129.1	4.97

† Included in preceding column

† Included in preceding column.  
‡ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depreciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
401		2,874.8				2,874.8	27,896	60	8,235	none	3,288
402	0.1	584.4				584.4	5,412	63	221	596	
403	5.0	2,801.5	2,026.7			4,828.2	127,622	162	55,057		43,897
404											
405											
406		14.5				14.5					870
407						none	11,079	170		650	1,272
408	0.6	204.7				204.7	2,326	83	385		475
409	23.8						3,950	120			
410	20.2					*108.7	679	49	321	16	none
411		231.4				231.4	2,536	69	none	none	none
412											
413	0.6	15.0				15.0	447	32	11,298	547	17
414	22.9	626.2				626.2	50,807	98	115,452	7,128	27,273
415	2.5	705.8				705.8	32,094	53	none	none	975
416	13.5	45.1				45.1	14,726	193	1,914	549	1,161
417	16.1					248.8	14,964	190	408	384	2,975
418						none	2,014	67	none	none	811
419	0.1	78.2				78.2	1,975	44	965	297	none
420		111.5				111.5	1,350	90	247	383	883
421	29.7					19.1	525	40			
422		14.9				14.9	4,364	291		35	375
423							615	36			
424		628.7				628.7	12,506	69	2,503	3,951	5,175
425	2.6		520.0			520.0	4,327	46			
426											
427		16.3	56.7			73.0	1,417	83	none	64	650
428		103.0				103.0	2,463	62	1,014	330	none
429						332.9	1,164	78	246	none	none
430		25.0				25.0	2,178	128		83	988
431		24.7		35.8		60.5	1,231	65	52		none
432	21.2					2,706.9	23,451	83	4,206	2,072	10,380
433	4.3	584.4				584.4	13,951	75	4,806	726	
434		483.1	325.9	5.8		814.8	6,250	57	1,684	3,765	3,587
435		75.0	2,048.8			2,123.8	15,007	86	none	352	8,809
436	17.8	359.6			2,150.0	2,509.6	2,219	25	704	40	6,000
437	34.8	164.3				164.3	6,463	92	2,169	973	1,000
438	28.8	84.1				84.1	11,352	152	11,214		
439		67.1	89.4			151.5	11,158	172	none	none	344
440	20.8										

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
401	1:1.9	1,923.6	185.3	250.6	907.2				11580.5	580.5
402	1:2.6	719.9			548.1	6.9		*163.9		
403	1:2.3	8,079.1	1,582.0		1,883.6	3,574.4		480.4	112,741.6	558.7
404	1:1.8	188.3	28.7		76.6	56.0				27.0
405	1:1.5	61.9								
406	1:1.1	8.3	30.0		14.5	26.5		-62.7		
407	1:2.3	451.6	18.1	25.0	210.3	114.8				83.4
408	1:2.1	207.0	11.3		60.9	37.5		15.0	82.3	
409	1:1.8	238.5							53.1	
410	1:1.4	51.7	0.9				35.5		17.6	-2.3
411	1:2.0	229.0			231.4	29.8				-32.2
412										
413	1:2.1	64.4		30.0					1117.7	34.4
414	1:2.1	2,821.1								
415	1:1.9	1,875.7	49.6	29.9	705.9	175.0		t892.1	11991.7	23.2
416	1:1.4	156.0	46.7				57.8		34.2	17.3
417	1:1.6	318.3	76.3	0.2		23.0	120.0		53.3	45.5
418	1:2.8	280.2			51.9			228.3		
419	1:1.7	165.6			56.1			t74.8	33.7	1.0
420	1:1.6	70.2	42.2			26.0		t9.7	1139.6	-7.7
421	1:1.5	62.1							1112.0	
422	1:1.5	35.0	7.7	21.0	14.9	14.0				-22.6
423	1:1.1	15.9	2.3					t9.7	7.7	0.8
424	1:2.2	991.3	76.6			273.0			11327.4	641.7
425	1:1.2	90.7	7.4		48.3	35.0			1178.6	
426										
427	1:3.6	185.6	26.6	19.0	16.3	18.0		121.7		-16.0
428	1:2.5	298.2						103.7	72.4	122.1
429	1:1.6	56.0	1.4					t10.0	1117.4	44.6
430	1:1.8	94.8	22.3		5.0	54.0				13.5
431	1:1.5	37.0	5.0							
432	1:1.6	1,462.2	304.8			40.0	563.2		11417.8	554.2
433	1:1.7	499.7			389.6			t67.0	11230.0	43.1
434	1:1.9	478.5	79.3			152.0			106.3	140.9
435	1:2.3	1,177.0	163.5		136.5	532.0			11441.3	345.0
436	1:2.0	667.4	209.6	150.6			161.3	x11.0	11109.6	134.9
437	1:1.5	342.0	40.0				180.0		1185.9	85.9
438	1:1.5	92.3							1125.5	
439	1:2.2	83.7	4.1			8.0		t16.1	111.9	43.6
440	1:1.3	40.6							17.0	

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
441. Superior, Wis.	190.0	60.6	46.8	4.5	301.9		85.9
442. Swampscott, Mass.							
443. Syracuse, N.Y.					1,808.5		
444. Tacoma, Wash.	751.4	575.8	127.1	15.5	1,469.8	77.9	50.9
445. Tampa, Fla. <sup>30/88</sup>				10.1	2,069.4	31.6	52.2
446. Taunton, Mass.	153.0	123.9	†		276.9	4.2	
447. Terrell, Tex. <sup>4/88</sup>							
448. Texarkana, Tex.	328.0	94.7	25.4	3.1	451.2	25.5	16.5
449. Texas City, Tex. <sup>7/88</sup>					255.3		
450. Toledo, Ohio				16.1	3,373.7		
451. Tonawanda, N.Y.	101.9	13.4	66.7		182.0		
452. Topeka, Kan.					1,261.7		
453. Torrance, Calif. <sup>7/88</sup>					667.0		
454. Torrington, Conn.	158.6	37.6	54.6	5.7	256.5	5.3	47.5
455. Tucson, Ariz. <sup>8/88</sup>					1,141.7	22.1	36.0
456. Tulare, Calif. <sup>7/88</sup>					133.7		
457. Tulsa, Okla. <sup>7/88</sup>					4,886.0		
458. Two Rivers, Wis.	75.2	17.4	30.2	1.3	124.1	7.2	28.0
459. Uniontown, Pa.	176.0	13.3	59.6	1.7	250.6		0.8
460. Vancouver, Wash.					414.5	31.7	
461. Ventura, Calif. <sup>7/88</sup>	264.0	42.0	132.3		438.3		
462. Vernon, Tex. <sup>4/88</sup>					165.9		
463. Vincennes, Ind.	†	156.9	41.8	2.8	201.5	16.7	35.1
464. Virginia, Minn. <sup>4/88</sup>	100.3	64.8			165.1		8.5
465. Walla Walla, Wash.					361.8		7.9
466. Wallingford, Conn.	†	143.4	78.4	3.5	225.3		15.4
467. Washington, D.C. <sup>7/88</sup>	2,592.9	4,087.4	†		6,680.3		
468. Washington, Ind.	†	117.8	22.9	1.4	142.1	26.9	
469. Washington C. H., Ohio*	74.6	21.8	19.8	1.2	117.4	4.1	6.8
470. Waterloo, Iowa					474.3		
471. Watertown, N.Y. <sup>7/88</sup>	233.3		101.6	9.4	344.3		
472. Watertown, S.D.					88.9		
473. Waterville, Me.	92.6	21.3	55.0	4.6	173.5	2.4	10.9
474. Waukegan, Ill. <sup>8/88</sup>					*590.4		5.1
475. Wauwatosa, Wis.	205.4	34.3	10.3	0.3	250.3	32.3	
476. Waycross, Ga.					215.5		
477. Webster, Mass.					65.9		
478. West Allis, Wis.	140.0	49.7	114.6	1.4	305.7		58.8
479. W. University Pl., Tex.*					126.6		
480. West View, Pa.	652.9	103.9	55.6	92.0	904.4	29.0	38.5

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
Revenue (cont'd.)				Free Service Value \$1,000	Expenses					
Misc. \$1,000	Total 6-9		Op. \$1,000		Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16		
	\$1,000	\$/cap.‡						\$1,000	\$/cap.‡	
441	0.2	388.0	11.08	none	152.9	49.9	78.7		281.5	8.04
442										
443	160.7	1,969.2	7.88		671.6	‡	130.6	173.0	975.2	3.90
444	56.1	1,654.7	10.03		677.0	207.7	51.8	0.3	936.8	5.68
445	6.5	2,159.7	9.19	none	847.1	‡			847.1	3.60
446	17.7	298.8	7.47	68.2	231.5	‡			231.5	5.79
447										
448		493.2	9.67	none	217.9	50.1			268.0	5.26
449	14.5	269.8	9.00	none	111.2	‡			111.2	3.71
450	520.8	3,894.5	8.60	304.0	1,746.4	846.1			2,592.5	5.72
451		182.0	10.71						152.5	8.97
452		1,261.7	10.34	1.0	693.1	151.9		85.8	930.8	7.62
453	114.0	781.0	17.35	15.1	94.0	275.3			369.3	8.20
454		310.3	12.41		60.7	23.0	60.2		143.9	5.75
455	26.0	1,225.8	13.03	none	546.2	‡	9.9		556.1	5.91
456		133.7	10.28		41.0	28.6		0.9	70.5	5.42
457	355.4	5,241.4	21.82						1,293.1	5.38
458	2.2	161.5	14.68	none	69.9	‡		16.4	86.3	7.84
459	18.9	270.3	10.81	none	113.3	32.4	10.5	22.0	178.2	7.13
460		446.2	8.12		172.1	42.9	15.4	4.7	235.1	4.28
461	59.0	497.3	16.05	2.9	231.7	‡		71.0	302.7	9.77
462		165.9	11.85							
463	0.2	253.5	10.57	none	76.5	9.6	2.1		88.2	3.68
464	1.0	174.6	11.64		124.5	11.3			135.8	9.08
465	20.2	389.9	14.45		196.4	‡	11.9	7.6	215.9	8.00
466		240.7	10.46	9.0	42.0	38.0			80.0	3.48
467	842.4	7,522.7	8.85	293.1	5,113.8	‡			5,113.8	6.02
468	5.8	174.8	13.45	none	58.0	‡	1.4		59.4	4.57
469	0.1	128.4	9.88	none	61.8	6.7	24.6	0.1	93.2	7.17
470		474.3	6.78	27.9	278.5	‡			278.5	3.98
471	34.0	378.3	9.96		212.1	52.1			264.2	6.96
472		88.9	6.35		73.1	‡			73.1	5.22
473		186.8	6.23	none	78.0	17.5			95.5	3.18
474	91.3	*686.8			304.6	‡			304.6	
475		282.6	7.64	none	182.0	45.0			227.0	6.14
476		215.5	10.26							
477		65.9	4.71	8.4					42.9	3.07
478	51.4	415.9	6.71		272.5	125.1			397.6	6.41
479	3.7	130.3	7.24		110.4	‡			110.4	6.14
480	25.3	997.2	10.50	none	366.0	116.3			482.3	5.08

‡ Included in preceding column.

§ Population served at retail.

TABLE 4—Part II (contd.)

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depreciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23	\$1,000	\$/cap.‡			
441	20.3	29.7				29.7					
442							9,071	36	6,465	347	2,678
443	6.6						24,300	147	8,869		7,679
444	3.1	166.2		1,464.4		1,630.6	14,783	63	121	277	13,267
445		779.3		548.6		1,327.9					
446			1,031.5			1,031.5	3,781	95			1,169
447											
448		64.8		521.2		586.0	6,842	134	1,035	1,354	
449							2,417	81			1,941
450		73.4		3,056.7		3,130.1	39,112	86			11,833
451			325.0			325.0					
452		403.6				403.6	4,007	33	1,912	none	368
453						142.7	3,004	67	714	863	2,085
454	19.4	2.6				2.6	2,077	83	541	89	490
455	0.8					none	10,828	115	none	629	6,460
456		23.4				23.4	826	64			
457						2,196.8	38,860	162			
458							1,326	120	260	496	487
459	3.9	52.8				52.8	1,471	59	484	355	none
460	3.4					401.3	4,906	89	721	18	665
461		24.0				24.0	3,575	105	154	23	none
462											
463	0.8	24.8		50.0		74.8	1,723	72		214	1,160
464							237	16	none	none	
465	3.1						‡2,766	‡102		3,080	950
466		75.0				75.0	2,386	104	565	1,209	
467		2,300.0			*3,000.0	5,300.0	‡71,831	‡85	none	325	1,900
468	0.8						1,322	102	177	554	315
469	19.2										
470						none	5,060	72	none	none	none
471				56.8		56.8	2,041	54	none	26	96
472							431	31			
473		33.3		41.9		75.2	‡2,735	‡91	566	174	911
474		42.9				42.9	3,265	67	73	308	690
475		63.0				63.0	1,853	50	738	252	202
476											
477						none	788	56	‡1417		
478							2,376	38			
479							618	34			
480						944.8	8,362	88			5,647

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

	1	30	31	32	33	34	35	36	37	38	39
		Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
				Interest	Debt Retirement Reserve	Capital Expense	Bonds Retired	Dividends	Paid to General Funds@	Depreciation	Added to Reserve
29	441	1:1.4	106.5								
	442										
2,678	443	1:2.0	994.0	99.9	168.3	241.6			*578.5	11232.0	-94.3
7,679	444	1:1.8	717.9	111.3		166.2	318.0		t120.6	11411.7	2.1
3,267	445	1:2.6	1,312.6	341.3	222.2	772.3	259.0		250.0	11638.5	106.3
	446	1:1.3	67.3	13.3			46.0		8.0		
1,169	447										
	448	1:1.8	225.2	154.8	128.9				t14.2		
1,941	449	1:2.4	158.6			53.6	194.0				
1,833	450	1:1.5	1,302.0	238.2	98.3		462.5				503.0
	451	1:1.2	29.5	11.7		12.0					5.8
368	452	1:1.4	330.9	7.7		134.4	46.0		t28.5	11114.3	114.3
2,085	453	1:2.1	411.7	24.9		142.7	89.0		t35.0	115.0	159.8
490	454	1:2.2	166.4	26.4		2.6	10.0	27.0	*64.2	36.2	
5,460	455	1:2.2	669.7	186.3		214.8	118.0		100.0		50.6
	456	1:1.9	63.2			23.4					39.8
	457	1:4.0	3,948.3		960.2				2,988.1	11547.8	
487	458	1:1.9	75.2	9.4					t36.8		29.0
one	459	1:1.5	92.1						x65.2	26.9	
665	460	1:1.9	211.1	6.9	33.5	66.6	25.0		t77.3	1177.1	1.8
one	461	1:1.6	194.6	33.4		24.0	74.0			1163.2	63.2
	462										
1,160	463	1:2.9	165.3	44.6		10.1	95.0			1115.6	15.6
	464	1:1.3	38.8	0.7		5.3	8.4			1123.5	24.4
950	465	1:1.8	174.0		75.0				t60.0		39.0
	466	1:3.0	160.7	4.5		126.2	21.0		9.0	1142.7	
900	467	1:1.5	2,408.9	¶		1,579.7	¶144.8				684.4
315	468	1:2.9	115.4	31.3					t1.0	17.2	65.9
one	469	1:1.4	35.2							10.4	
	470	1:1.7	195.8							1184.5	
96	471	1:1.4	114.1	1.9		64.9	6.0				41.3
	472	1:1.2	15.8								
911	473	1:2.0	91.3	17.2	24.6	45.5			t4.0		
690	474		382.2	144.0	39.0	42.9	55.0			*318.6	77.3
202	475	1:1.2	55.6	3.5			19.0		t34.1	1141.3	
	476										
	477	1:1.5	23.0								
	478	1:1.0	18.3						t32.5	1120.5	-14.2
	479	1:1.2	19.9			40.8					-20.9
647	480	1:2.1	514.9	124.3	75.0	100.0	90.0				125.6

# Ratio of expenses (Col. 17) to revenue (Col. 10).

¶ Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

1	2	3	4	5	6	7	8
Community*	Revenue—\$1,000 units						
	Resid.	Coml.	Ind.	Pvt. Fire	Total 2-5	Munic.	Pub. Fire
481. Westchester Co., N.Y.*					538.0		51.2
482. Westerly, R.I.				1.4	198.5		9.4
483. Westmoreland Co., Pa. <sup>4/55</sup>							
484. Weymouth, Mass.	254.0	40.0			294.0		
485. Whittier, Calif. <sup>7/55</sup>					502.4	1.5	
486. Wichita, Kan.*					3,719.6	86.3	174.5
487. Wilkesburg-Penn., Pa.	1,138.6	87.1	482.2	11.5	1,719.4	25.0	76.8
488. Williamsport, Pa. <sup>7/55</sup>	273.4	57.8	98.3	6.6	436.1	15.0	29.2
489. Wilmington, N.C. <sup>7/55</sup>					573.0		
490. Wilson, N.C. <sup>7/55</sup>	123.7	47.9	16.1		187.7	30.0	8.1
491. Winnetka, Ill. <sup>4/55</sup>					248.6		9.3
492. Wisconsin Rapids, Wis.	89.4	49.6	35.8	1.7	176.5	1.0	54.1
493. Worcester, Mass.					1,649.7		
494. Wyandotte, Mich. <sup>10/55</sup>					273.4		
495. Yonkers, N.Y.							
496. York, Pa.	918.4	117.6	280.4	25.7	1,342.1	13.2	40.2
497. Youngstown, Ohio	†	1,266.0	300.9	2.0	1,568.9		

\* See notes beginning on p. 694.

† Included in "Coml."

1	9	10	11	12	13	14	15	16	17	18
	Revenue (contd.)			Free Service Value \$1,000	Expenses					
	Misc. \$1,000	Total 6-9			Op. \$1,000	Maint. \$1,000	Taxes \$1,000	Misc. \$1,000	Total 13-16	
		\$1,000	\$/cap.\$						\$1,000	\$/cap.\$
481	28.3	617.5	14.70		313.5	127.7	1.5		442.7	10.53
482		207.9	11.55		37.6	‡			37.6	2.09
483		2,169.3	14.85		517.6	127.1			644.7	4.41
484		294.0	7.00		67.4	151.7			219.1	5.22
485	45.1	549.0	17.16	1,000.0	66.0	225.7			291.7	9.12
486	12.7	3,993.1	16.84	none	998.0	157.0	804.1	53.3	2,012.4	8.48
487	4.6	1,825.8	8.70	none	871.4	146.2	10.7		1,028.3	4.90
488	11.2	492.5	8.21	none	122.4	31.0			153.4	2.56
489		573.0	10.43	46.4	113.9	225.0		4.4	343.3	6.25
490	60.1	285.9	10.21	none	99.7	18.0			117.7	4.20
491	28.4	286.3	20.45	none	134.0	17.0			151.0	10.78
492		231.6	16.54							
493		1,649.7	7.94		69.0	498.5			567.5	2.73
494	130.4	403.8	9.62	27.4	177.2	‡		6.9	184.1	4.38
495		1,477.7	9.24						1,410.9	8.82
496	31.4	1,426.9	14.27	none	436.6	40.0	434.7	9.1	920.4	9.20
497	175.4	1,744.3	8.90	191.5	1,008.7	532.9			1,541.6	7.87

‡ Included in preceding column.

§ Population served at retail.

1	19	20	21	22	23	24	25	26	27	28	29
*	Tax Paid (% of Total Rev.)	Source of Funds for Capital Additions—\$1,000					Book Value (Depreciated)		Depre- ciation Reserve Funds \$1,000	Surplus in Reserve \$1,000	Funded Debt \$1,000
		Prior Earnings	G.O. Bonds	Revenue Bonds	Bank Loans	Total 20-23					
							\$1,000	\$/cap.\$			
481	0.2										
482		38.5				38.5	1,888	105			33
483							25,969	178			
484		0.1	17.1	55.6		72.8				39	342
485		43.0	165.6			208.6	5,055	158	none	132	
486	20.2										
487	0.6	983.3				983.3	15,191	72	3,722	3,041	8,840
488		116.2				116.2	6,809	113	344		5,452
489		33.1				33.1	5,068	92	none	none	3,039
490		95.9				95.9	3,112	111	208		717
491		60.9				60.9	1,491	106	424	5	none
492											
493			1,798.7			1,798.7	22,220	107			6,737
494		755.7				755.7	2,324	55			15
495											
496	30.5	336.5	1,000.0			1,336.5	6,500	65	1,474	1,295	1,980
497		210.7				210.7	4,587	23			275

\* See Col. 1 of preceding left-hand page and notes beginning on p. 694.

† Customer contributions toward construction.

‡ Undepreciated.

§ Population served at retail.

|| Accounting record.

1	30	31	32	33	34	35	36	37	38	39
	Operating Ratio #	Earnings (Col. 10 Minus Col. 17) \$1,000	Disposition of Earnings—\$1,000 units							
			Interest	Debt Retire- ment Reserve	Capital Expense	Bonds Retired	Divi- dends	Paid to General Funds@	Depre- ciation	Added to Reserve
481	1:1.4	174.8						174.8		
482	1:5.5	170.3			38.5					
483	1:3.4	1,524.6								
484	1:1.3	74.9	6.8			45.0				23.1
485	1:1.9	257.3	202.1		6.1			*47.1	1107.7	2.0
486	1:2.0	1,980.7	390.7	567.0	145.8	174.2			281.5	
487	1:1.8	797.5	200.7	205.0	384.6				11205.0	7.2
488	1:3.2	339.1	115.3	3.0		128.2				92.6
489	1:1.7	229.7	77.7		33.1	93.9		25.0		
490	1:2.4	168.2	20.0		95.9	24.7			*147.7	
491	1:1.9	135.3			60.9			49.3	20.1	5.0
492								t25.2		
493	1:2.9	1,082.2				990.6				
494	1:2.2	219.7	3.8		137.9	15.0			1163.0	63.0
495	1:1.0	66.8								
496	1:1.6	506.5	66.0				288.0		1134.7	152.5
497	1:1.1	202.7	6.0		74.0	25.0			1125.2	97.7

# Ratio of expenses (Col. 17) to revenue (Col. 10).

\* Interest included in Col. 35.

@ Letters preceding certain entries indicate that amounts shown also include (or consist entirely of) "local taxes" (t) paid by publicly owned utilities, payments to regional water districts (d), sewer system allocations (s), and outlays for purposes other than those itemized in this table (x).

## Notes to Survey Tables

### Applicable to All Tables

Data shown in all tables are for the year 1955, except as indicated by superscript numerals following the name of the community; for example, <sup>2/86</sup> indicates that data are for the year beginning March [first] 1955.

Communities are arranged alphabetically and are numbered consecutively; a given community will have the same number in every table. The italic number preceding each of the notes below is the community number.

The following notes give the full name of communities listed in abbreviated form in the tables; some notes contain other relevant information regarding the particular community or the utility serving it:

- 86. Includes Urbana, Ill.
- 134. East Bay Municipal Utility District (Oakland, Calif.).
- 202. Water Bureau of the Metropolitan District of Hartford County.
- 208. Hawaii County Board of Water Supply (manages 21 systems on the island of Hawaii).
- 243. Florida Keys Aqueduct Commission.
- 253. Helix Irrigation District (formerly La Mesa, Lemon Grove, and Spring Valley Irrigation District).
- 270. That portion of the island served by Long Island Water Corporation.
- 280. Manhattan Beach, Calif.
- 292. Merrick plant of New York Water Service Corporation.
- 294. Metropolitan Water District of Southern California.
- 321. Central Louisiana Electric Company, serving also Crowley, Eunice, and other areas.
- 326. Includes Hampton and Warwick, Va.
- 358. Passaic Valley Water Commission.
- 363. Philadelphia Suburban Water Company.
- 376. Puerto Rico Aqueduct and Sewer Authority (includes all suburban communities—more than 70—on the island).
- 377. Woodhaven plant of New York Water Service Corporation.
- 386. Rochester plant of New York Water Service Corporation.
- 414. Scranton-Spring Brook Water Service Company, serving also Wilkes-Barre and more than 50 other communities.

- 416. Roaring Creek Water Company.
- 417. Shenango Valley Water Company.
- 432. Southern California Water Company (serves 25 separate districts, mainly in Los Angeles County).
- 469. Washington Court House, Ohio.
- 479. West University Place, Tex.
- 481. Westchester Joint Water Works No. 1.
- 486. Supply and treatment facilities municipally owned; pumps and distribution system privately owned during period of survey. Financial data (Table 4) represent combined figures for supply (municipal) and distribution (private).

### Table 1

*For notes to Col. 1, see notes applicable to all tables (above).*

- 28. Col. 2: Varies from 65,000 in winter to 125,000 in summer.
- 91. Col. 3: Includes 675,000 suburban population, largely wholesale.
- 91. Col. 8: Chlorination, 100 per cent; filtration, 35 per cent.
- 208. Col. 8: Of 21 systems, 4 use filtration and 6 chlorination.
- 208. Col. 10: Of 21 systems, 20 are gravity supply.
- 210. Col. 2: Varies from 35,000 in summer to 72,000 in winter.
- 211. Col. 8: Approximately 5 per cent of supply.
- 250. Col. 2: Varies from 16,000 in summer to 32,000 in winter.
- 294. Col. 3: Supplemental (wholesale) supply to more than 6,000,000 people.
- 324. Col. 6: Ground water, 0.3 per cent; surface water, 99.7 per cent.
- 486. Col. 4: Supply and treatment facilities municipally owned; pumps and distribution system privately owned during period of survey.

### Table 2

*For notes to Col. 1, see notes applicable to all tables (above).*

- 19. Col. 13: Flood loss and cleanup.
- 45. Col. 11: An additional 15,585 mil gal of raw water was delivered to industrial users.
- 137. Col. 13: Plant use.

183. Col. 11: An additional 2,417 mil gal of raw water was used for condenser cooling at the city power plant.

276. Col. 13: Fire service.

298. Col. 11: 5,301 mil gal was pumped from Lake Huron, of which 30 per cent (1,608 mil gal) was treated, and the remainder untreated for industrial use.

414. Col. 2, 5: Transmission mains included in Col. 5.

441. Col. 13: Company use.

### Table 3

*For notes to Col. 1, see notes applicable to all tables (p. 694).*

18. Col. 18: Ranges from \$30.00 to \$50.00.

23. Col. 4: Includes 1,909 apartments.

26. Col. 12: Discount of \$0.20 per 1,000 cu ft.

29. Col. 8: Commercial, 18 per cent; industrial, 64 per cent.

30. Col. 18: Outside city only.

32. Col. 8: Commercial 76 per cent; industrial, 100 per cent.

32. Col. 18: Ranges from \$30.00 to \$60.00.

35. Col. 18: In surrounding counties only.

36. Col. 8: Commercial, 93 per cent; industrial, 94 per cent.

41. Col. 8: Commercial, 100 per cent; industrial, 65 per cent.

49. Col. 8: Commercial, 100 per cent; industrial, 84 per cent.

60. Col. 14-17: Quarterly.

62. Col. 14-17: Quarterly.

65. Col. 8: Commercial, 25 per cent; industrial, 28 per cent.

76. Col. 18: \$40.00 in Burlington Township Water District.

81. Col. 18: Ranges from \$25.00 to \$30.00.

95. Col. 7: Includes 978 charitable institutions and 5 suburban master meters.

96. Col. 8: Commercial, 97 per cent; industrial, 100 per cent.

97. Col. 7: Wholesale only, to systems comprising 18,300 retail services.

103. Col. 8: Commercial, 99 per cent; industrial, 100 per cent.

103. Col. 18: Ranges from \$30.00 to \$68.18.

123. Col. 8: Commercial, 86 per cent; industrial, 56 per cent.

132. Col. 18: \$60.00 outside city limits.

134. Col. 18: Charge is made for cost of installing hydrants.

139. Col. 19: \$36.96 per mile for mains larger than 6 in.

149. Col. 8: Commercial, 31 per cent; industrial, 58 per cent.

149. Col. 18: Outside city only.

167. Col. 8: Commercial, 14 per cent; industrial, 100 per cent.

222. Col. 18: Outside city only.

227. Col. 8: Commercial, 100 per cent; industrial, 91 per cent.

227. Col. 18: \$45.00 outside city limits.

235. Col. 12: Penalty of \$1.00 per 1,000 cu ft.

246. Col. 19: Per mile.

247. Col. 8: Commercial and industrial, 97 per cent.

256. Col. 8: Commercial and industrial, 88 per cent.

257. Col. 8: Has 25 metered accounts.

258. Col. 8: Commercial, 32 per cent; industrial, 100 per cent.

278. Col. 18: Outside city only.

292. Col. 18: Ranges from \$45.00 to \$55.00.

294. Col. 7: Wholesale only; supplemental supply to more than 6,000,000 people.

304. Col. 14-17: Includes sewer service charge.

314. Col. 12: Penalty of \$0.20 per 1,000 cu ft.

331. Col. 14-17: Quarterly.

349. Col. 18: Ranges from \$15.00 to \$42.50.

363. Col. 8: Commercial, 100 per cent; industrial, 21 per cent.

364. Col. 15-17: Rates shown are for winter season; corresponding summer rates are \$11.90, \$106.90, and \$764.03.

367. Col. 8: Commercial, 97 per cent; industrial, 45 per cent.

372. Col. 8: Commercial, 96 per cent; industrial, 100 per cent.

373. Col. 18: Ranges from \$30.00 to \$50.00.

375. Col. 8: Commercial, 100 per cent; industrial, 94 per cent.

376. Col. 8: Commercial, 95 per cent; industrial, 99 per cent.

386. Col. 18: Ranges from \$45.00 to \$75.00.

387. Col. 8: Commercial, 45 per cent; industrial, 100 per cent.

408. Col. 5: Includes 89 irrigation customers.

410. Col. 5: Includes 40 irrigation customers.

410. Col. 18: \$6.00 for 4-in. diameter or less; \$12.00 if greater than 4 in.

414. Col. 8: Commercial, 53 per cent; industrial, 97 per cent.

414. Col. 18: \$30.00 in Scranton area; \$20.00 in Wilkes-Barre area.

416. Col. 14-17: Rates shown are for gravity supply; for pumped supply, add \$0.90 per 1,000 cu ft.

417. Col. 19: Per mile.

419. Col. 19: Per mile.

422. Col. 4: Includes customers outside city limits.

429. Col. 10: Billing every 4 months.

433. Col. 10: Billing every 4 months.

441. Col. 8: Commercial, 100 per cent; industrial, 86 per cent.

456. Col. 8: Commercial, 93 per cent; industrial, 100 per cent.

473. Col. 8: Commercial, 87 per cent; industrial, 71 per cent.

483. Col. 11, 13-19: Rates and charges vary in numerous districts served.

486. Col. 8: Commercial, 99 per cent; industrial, 83 per cent.

488. Col. 19: Varying schedule of charges.

496. Col. 8: Commercial, 71 per cent; industrial, 70 per cent.

#### Table 4

*For notes to Col. 1, see notes applicable to all tables (p. 694).*

8. Col. 35: \$400,500 in tax funds allocated to debt service.

41. Col. 32: Includes \$4,700 interest on unfunded debt.

54. Col. 6: Includes \$162,000 wholesale revenue.

126. Col. 6: Includes \$4,320,300 suburban sales revenue.

134. Col. 8: Tax revenue.

202. Col. 23: In anticipation of bond issues.

202. Col. 33: Includes \$78,600 in amortization and capitalization charges.

208. Col. 23: Customer contributions and county loans.

237. Col. 6: Includes \$1,169,700 suburban sales revenue.

267. Col. 6: Includes \$208,800 wholesale revenue.

267. Col. 38: \$55,100 to depreciation reserve; \$70,700 accounting record only.

273. Col. 5: Included in Col. 2-4.

273. Col. 17: \$420,800 depreciation item credited.

292. Col. 6: Includes \$64,100 wholesale revenue.

295. Col. 6: Includes \$1,209,700 wholesale revenue.

300. Col. 6: Includes \$540,700 wholesale revenue.

313. Col. 21: Serial notes.

320. Col. 24: Includes \$2,000,000 stock issue and \$168,000 in customer contributions.

376. Col. 24: Includes \$4,746,700 in contributions toward construction.

376. Col. 25: Includes sewer and electric properties.

380. Col. 4: Untreated water for irrigation.

386. Col. 6: Includes \$396,200 wholesale revenue.

392. Col. 6: Includes \$154,900 wholesale revenue.

392. Col. 22: \$1,700,000 first mortgage and \$3,000,000 preferred stock.

402. Col. 37: Includes \$52,400 for litigation.

403. Col. 6: Includes \$3,853,300 suburban sales revenue.

410. Col. 24: Preferred stock.

416. Col. 6: Includes \$55,000 wholesale revenue.

422. Col. 6: Includes \$12,500 wholesale revenue.

443. Col. 37: Includes \$29,400 charged to damages sustained.

454. Col. 37: Charged to flood damage.

467. Col. 23: United States government loan.

474. Col. 6, 10: Combined water and sewer utility revenue.

474. Col. 38: \$171,300 to depreciation reserve; \$147,300 accounting record only.

485. Col. 37: Refunds on donations.

490. Col. 38: \$104,100 to depreciation reserve; \$43,600 accounting record only.

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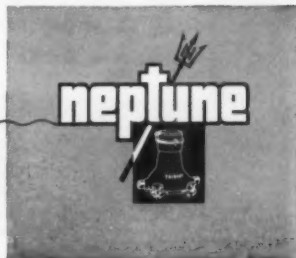
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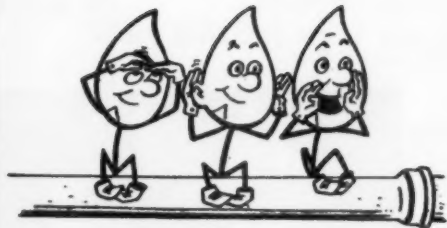
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## Percolation and Runoff

**Water Works Week 1957** was inaugurated on May 12, when AWWA's 77th Annual Conference opened in Atlantic City. That it was a big week is certain, although our story of how big will have to await the confirmation of fact. Meanwhile, more and more, every week seems to be water works week in the news, until the publicity we once had to hunt now threatens at times to overwhelm us.

As usual the largest headlines have continued too "too" for our taste, accentuating the negatives of too much water or too little. Actually, in terms of publicity, "too much" falls far short of "too little," for though floods do make a big splash, they usually recede relatively quickly. "Too little," on the other hand, more or less spectacularly is the source of practically all the water news—from such full-scale coverage as received by the Southwest drought to the localized handling of such a story as that of the recent engineering survey of Nassau County, N.Y., which indicated that its water use would double by the year 2000, requiring augmented supply systems to handle a demand of 252.5 mgd. Too little, too, is behind the current rash of stories on the conversion of saline water to fresh at costs said now to reach as low as 30 cents per thousand gallons, the renewal of the California-Arizona legal battle for the waters of the Colorado River, the

plans to advance \$100,000,000 in loans for Texas city, county, and state water supply projects, the consideration by the legislatures of practically all 37 "riparian" states of the "new" problem of water rights, the discussion of a federal water supply agency to protect the public interest in the proper use of the nation's water resources. Even such stories as that of the current arguments of Detroit and surrounding Wayne County authorities over the responsibility for the future water supply of the area and the news that the Indianapolis Water Co. has retained the firm of Alvord, Burdick & Howson, together with consultants Samuel B. Morris and Abel Wolman, to consider the long-range future of the Indianapolis area and to make recommendations for providing the water it needs are based on the fear of "too little" later.

That "too little" isn't confined to "the land of plenty" is quite clear. In our own neighborhood, Canada is now talking of diverting 29,000 cfs from the Columbia and Kootenay rivers without even waiting for a US okay, and in Mexico the Dept. of Water Resources is planning to spend some \$16,000,000 for improving small village water supplies. Further away, "too little" has impelled the island of Aruba to install a 2.7-mgd sea water distillation plant, operating on the inexpensive fuel from

*(Continued on page 34 P&R)*

(Continued from page 33 P&amp;R)

nearby Lago refinery, to provide water not only for domestic uses but for the ultimate in irrigation—hydroponics—as well. And at Rio, news of a 2- or 3-day-a-week supply is attributed to a system designed for 2,000,000 trying to serve 3,000,000. Even in Switzerland there are water worries, with industrial and domestic wastes beginning to foul many of those crystal-clear Alpine lakes. And the struggles of Israel and Syria over the waters of the River Jordan as well as those of India and Pakistan over the Indus are enough to carry the too-littleness at least halfway around the world.

That all the too-littleness is a matter of water supply rather than water resources, however, ought to be obvious from the fact that we now use only about 5 per cent of the rainfall available to us. The \$100,000,000 a year that the rejuvenated Soil Conservation Service will be spending on watershed conservation and flood prevention by the mid-1960's ought to help, as would the "network of water pipelines across the country . . . carrying water from sources of supply—including desalting plants—to areas where it's needed" foreseen by Interior Secretary Fred Seaton. Certainly a nation that can afford to spend \$50,000,000,000 a year for defense can afford to realize the goal of "All the Water You Need, When and Where You Need It!" And if it makes up its mind to, we really can make headlines of Water Works Week instead of water works weak.

**Water Works Strong**, on the other hand, are the new officers and directors taking the reins of AWWA on Friday, May 17, at Atlantic City, led by Prexy Fred Merryfield and Veep



Lew Finch, who apparently (see photo above) had their part in the act all cooked up way back in 1954, when Karl Mann, snapping then for *Water Works Engineering*, caught them in this chummy pose. Actually both were completely unofficial in those days, and Karl deserves a posy for his foresight. As for Fred and Lew and the rest of the crew, they get theirs below:

**President—Fred Merryfield**, professor of sanitary engineering, Oregon State College, and consulting engineer, Cornell, Howland, Hayes & Merryfield, Corvallis, Ore. Born in 1900, he received a B.S. degree from Oregon State College (1923) and an M.S. from the University of North Carolina (1930), and is a registered professional engineer in Oregon. He served as engineer with the Southern Pacific Railroad and US Army Corps of Engineers from 1923 to 1927. In 1927, he joined the faculty of Oregon State College as an instructor in the department of engineering, and served in that capacity until 1929, when he was appointed assistant engineer to the Dept. of Conservation and Natural Resources of North Carolina. In 1930, he returned to Oregon State College, where he served until 1942 as, succes-

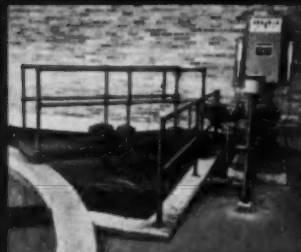
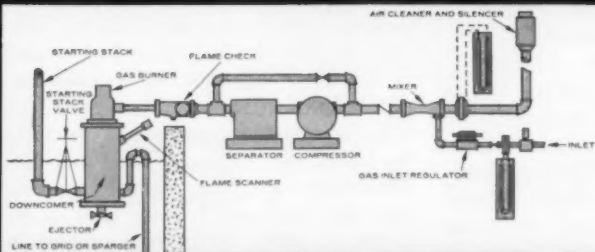
(Continued on page 36 P&amp;R)

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(Continued from page 34 P&amp;R)

sively, assistant and associate professor, engaged in teaching, research, and the design of water, sewage, and hydroelectric facilities. In 1943 he entered service as a staff officer and served with the Sixth Army in the Southwest Pacific Area until 1944. Since 1945 he has served in his present capacity as professor and consultant in sanitary engineering at Oregon State College, and as a member of the Oregon State Water Resources Board.

An AWWA member since 1934, he has been secretary-treasurer (1936-43 and 1945-49) and director (1950-53) of the Pacific Northwest Section, which gave him its Fuller Award in 1944. He served successively as trustee (1950-52), secretary (1952-53), and chairman (1953-54) of the Water Resources Division. Committees on which he has been a member include Water Works Research Needs, Education, and the 1954 Convention Management Committee. In 1955 he served as chairman of the Harry E. Jordan Scholarship Award Committee, and in 1956-57 he was AWWA vice-president.

Other organizations with which he is affiliated include ASCE, FSIWA, the Pacific Northwest Sewage & Industrial Wastes Assn. (past chairman), the American Society for Engineering Education, and the Willamette River Basin Committee. He is presently vice-chairman of the Region VII Education and Accreditation Committee of the Engineers' Council for Professional Development.

**Vice-President—Lewis S. Finch,** vice-president and chief engineer, Indianapolis Water Co., Indianapolis, Ind. Born in Anna, Ill., in 1897, he attended Purdue University, from



V.P.—Finch



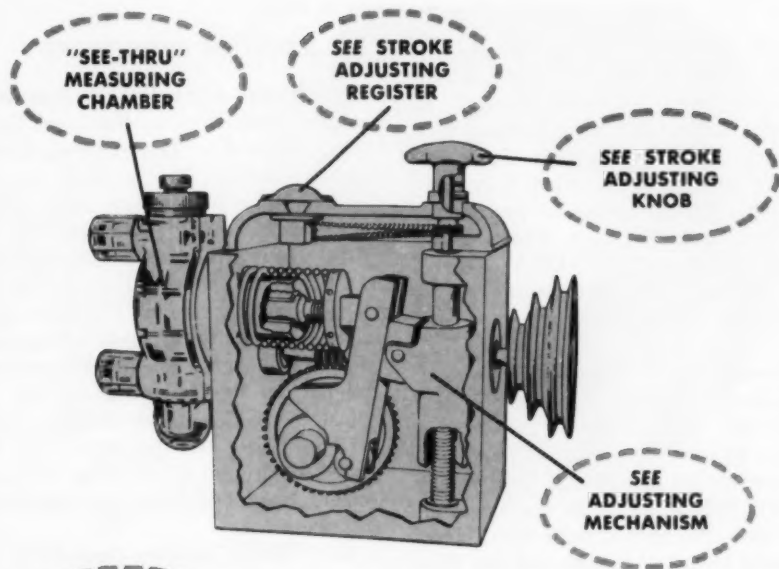
Treas.—Orchard

which he was graduated in 1921, receiving the civil engineering degree in 1931. He is a registered professional engineer in Indiana. In the employ of the Milwaukee Sewerage Commission as senior engineer from 1923 to 1925, he joined the Indiana Board of Health in the latter year, serving as chief engineer until 1933, when he opened an office as consulting engineer. In 1942 he joined the Indianapolis Water Co. as principal assistant engineer, becoming chief engineer 2 years later, a director in 1948, and vice-president in 1950.

A corporate representative or active member of AWWA since 1926, he has been vice-chairman (1931), chairman (1932), and national director (1952-55) for the Indiana Section, which nominated him for the Fuller Award in 1949. His extensive committee activities have included vice-chairmanship of the Committee on Water Works Administration and chairmanship of the Committee on Water Main Extension Policy and the Committee on Public Use of Watershed Areas.

He has also been a member of the Ohio River Board of Engineers, the Great Lakes Board of Engineers, the Advisory Board of the Indiana Administrative Building Council, and the Indiana Advisory Health Council. At

(Continued on page 38 P&amp;R)



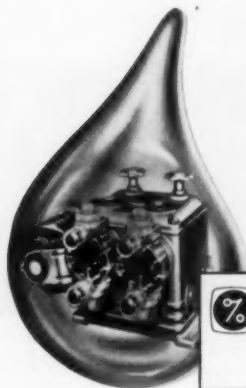
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(Continued from page 36 P&amp;R)

present he is vice-chairman of the Indiana Stream Pollution Control Board. Other technical societies to which he belongs are ASCE (past president, Indiana Section), Indiana Engineering Society (past president), Indiana Engineering Council (past president), Central States Sewage Works Assn. (past president), FSIWA (director), Indianapolis Construction League (president), and NSPE.

**Treasurer—William J. Orchard**, consultant, Wallace & Tiernan Inc., Belleville, N.J. Born in Boston, Mass., in 1888, he was graduated from Massachusetts Institute of Technology in 1911 with a degree in sanitary engineering. He served with the Massachusetts Board of Health and the Metropolitan Water Commission, and also held the post of assistant sanitary engineer with the New Jersey Health Dept. In 1915 he entered the employ of the Wallace & Tiernan organization. During World War I he originated and developed mobile water purification equipment for the US Army. He rose to the position of general manager of Wallace & Tiernan, retiring in 1954 but continuing as consultant to the company.

An Honorary Member of AWWA (joined in 1917), he received the Diven Medal in 1954 and the Jordan Achievement Award in 1956. A director for many years, he has served as chairman of the Convention Management Committee and as a member of the Executive Committee and the General Policy Committee. Since 1951 he has been chairman of the Finance Committee. Other organizations to which he belongs include WSWMA (past president), NEWWA, FSIWA, and APHA.

## SECTION DIRECTORS

**California—Cornelius P. Harnish**, president and director, Southern California Water Co., Los Angeles, Calif. Born in Butler, Pa., in 1892, he received a B.S. in sanitary engineering from the University of Pittsburgh in 1915. He is a registered civil engineer in California. From 1916 to 1918 he worked as an assistant engineer with the consulting firm of Morris Knowles, Inc., Pittsburgh. He was engineer and partner in the consulting firm of Olmsted & Gillelen, Los Angeles, from 1918 to 1929. In the latter year he joined his present company as chief engineer, later becoming vice-president and president.

An AWWA member since 1929, he served as chairman of the California Section in 1945, after 6 years as a member of its executive committee. He also belongs to ASCE.

**Chesapeake—Robert W. Haywood Jr.**, consultant on water and waste treatment, Engineering Service Div., Engineering Dept., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Born in New Bern, N.C., in 1906, he was graduated from North Carolina State College in 1928 with a B.S. in chemical engineering. He is



California—  
Harnish



Chesapeake—  
Haywood

(Continued on page 42 P&amp;R)

*here's what  
"out of sight  
out of mind"  
does to a  
water main*



"Out of sight—out of mind" can be a mighty expensive philosophy in any water distribution system. The above unretouched photograph proves this point. It shows a badly tuberculated eight inch main whose inside diameter was reduced to an average of almost 4.5 inches. Resultant higher pumping costs with reduced pressure and carrying capacity make it costly to tolerate such conditions. That is why the savings effected in reduced pumping costs frequently pay for the low cost of National water main cleaning.

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Pipe, like chain, must be strong in *all* elements.

Listed below are five factors of strength that have enabled cast iron pipe to achieve a record of dependability and long life unmatched by any other.

44 North American cities are still being served by cast iron water mains laid a century or more ago. Hundreds of others have passed the 50 year mark.

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The record proves it!

---

### DEPENDABILITY IS BASED ON STRENGTH- STRENGTH IS BASED ON THESE **5** FACTORS

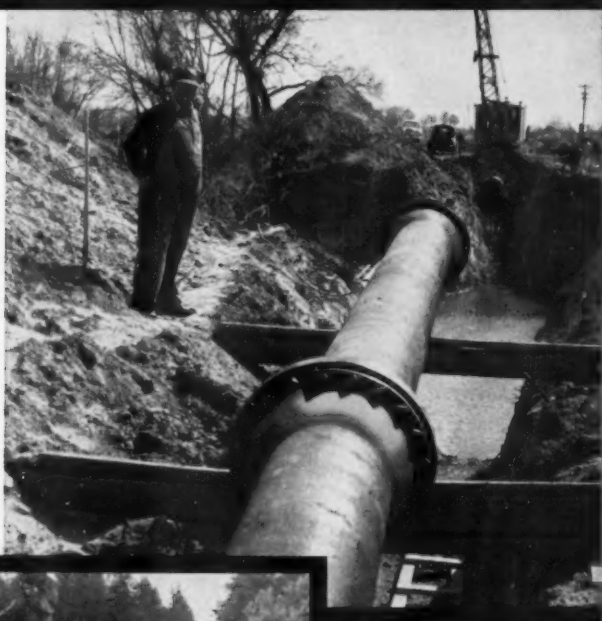
1. **CRUSHING STRENGTH\*** . . . Standard 6" Class 150 cast iron pipe will withstand a crushing load, under standard tests, of 17,900 pounds per foot. . . important where heavy fill or unusually heavy traffic loads must be overcome.
2. **BEAM STRENGTH\*** . . . Settlement or disturbance of the soil by other utilities or resting on an obstruction places a heavy strain on pipe. 6" class 150 pipe bears up under a load of 20,790 pounds and deflects 2.32 inches.
3. **BURSTING STRENGTH\*** . . . The average of many tests prove that standard 6" class 150 cast iron pipe will not burst until subjected to internal pressure of 3000 pounds psi . . . ample to resist water hammer or unusual working pressures.
4. **JOINT STRENGTH** . . . A full range of leak-proof, low cost, easy-to-assemble joints and fittings are available to meet all conditions.
5. **CORROSION RESISTANCE** . . . Cast Iron Pipe resists corrosion effectively . . . vital factor in its demonstrated long life and dependability.

\*Based on independent laboratory tests.

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# CAST IRON PIPE

...sum of many parts...



▲ River crossing installation of 16" flexible joint cast iron pipe at Salina, Kansas.

▲ Greensboro, N. C.—installing dual water lines with new 30" Mechanical Joint cast iron pipe, plus salvaged 24" Bell-and-Spigot cast iron raw water line in service approximately 25 years.



Cast Iron Pipe Research Association  
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 Suite 3440, Prudential Plaza, Chicago 1, Ill.

**SERVES FOR CENTURIES...**

(Continued from page 38 P&amp;R)

**Cuban—Daniel****Fla.—Eidsness**

a licensed professional engineer in Pennsylvania, and holds operator's certificates from Texas and Illinois. After serving as a junior bacteriologist with the Bureau of Sanitary Engineering of the North Carolina Dept. of Health in 1929-30, he went to Gastonia, N.C., as city chemist, in charge of water and sewage plant operation. During 1932-36 he was superintendent of filtration for Lehigh Water Co. (later city of Easton), Easton, Pa. In 1936 he became technical sales representative for Industrial Chemical Sales Div., West Virginia Pulp & Paper Co., New York, leaving in 1941 to take the post of filtration plant chemist for the Chester (Pa.) Municipal Authority. Since 1942 he has supervised water and waste treatment for a number of ordinance and chemical firms. He accepted his present position with du Pont in 1951.

An AWWA member since 1937, he has been trustee and vice-chairman of the Chesapeake Section. AWWA committees on which he has served include Capacity and Loadings of Water Treatment Processes, Industrial Water Use, and Revision of Manual of Water Quality and Treatment. He is also a member of FSIWA.

**Cuban—Laurence H. Daniel**, president and chief engineer, Laurence H. Daniel, Inc., Engrs., Havana, Cuba. Born in 1901, he holds degrees from La Salle College in Havana and Cornell University. He is a registered engineer in Cuba. He was instrumental in introducing chlorination in Cuba and has been active in all branches of water purification for the past 30 years. In 1949 he invented the Daniel system of cane juice sterilization, bringing to the sugar industry much of the technique used in water purification.

An AWWA member since 1939, he served the Cuban Section as secretary from 1940, the year it was founded, until 1956. His active role in Section affairs earned him the Fuller Award in 1953. Other professional societies to which he belongs are Cuban Society of Engineers, Inter-American Assn. of Sanitary Engineering, Sugar Technologists Assn., and FSIWA.

**Florida—Fred A. Eidsness**, vice-president, Black & Assocs., Inc., and Black Labs., Inc., Gainesville, Fla.; research professor, Div. of Water Research, University of Florida, Gainesville. Born in Washington, D.C., in 1913, he holds a B.S. from the College of William and Mary (1936) and a Ph.D. from the University of Florida (1956). He is a licensed professional engineer in Florida.

An AWWA member since 1941, he has been trustee and chairman of the Florida Section, which nominated him for the Fuller Award in 1944. Other professional organizations to which he belongs include AICHE, ACS, ASCE, NSPE, Florida Sewage & Industrial Wastes Assn., and Florida Engineering Society (senior member).

(Continued on page 44 P&amp;R)

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(Continued from page 42 P&amp;R)



Ill.—Gerstein



Mont.—Thomas

**Illinois—H. H. Gerstein**, assistant chief water engineer, Bureau of Water, Dept. of Water & Sewers, Chicago, Ill. A chemical engineering graduate of Armour Institute of Technology, his early experience was in the meat-packing business. He then became associated with—and for many years served as chief of—the Water Safety Control Section of Chicago's Water Purification Div. During World War II he was a major in the Sanitary Corps, attached to the Air Force. After 7 years as chief filtration chemist in charge of Chicago's South Dist. Filtration Plant, he succeeded to his present position in 1952. One of the country's leading authorities on the subject, he did much to establish the concept of free residual chlorination. He also developed a continuous odor monitor.

A Life Member of AWWA (joined in 1925), he is chairman of the Water Purification Division. In 1955 he was tendered the Fuller Award by the Illinois Section, of which he is past chairman.

**Montana—David S. Thomas**, district engineer, Board of Fire Underwriters of the Pacific, Great Falls, Mont. Born in 1893, he holds a degree in civil engineering from Montana State College (1917) and is a registered professional civil engineer. After

2 years with an irrigation project and a term of military service, he entered the employ of his present organization in 1920 and has since been engaged in fire protection engineering.

An AWWA member since 1927, he has been vice-chairman and chairman of the Montana Section, which nominated him for the Fuller Award in 1944. He is also a member of the Society of Fire Protection Engineers.

**North Central—L. H. Coult**, chemist and superintendent of water treatment, Water & Light Commission, Fairmont, Minn. Born in 1900, he was graduated as a chemical engineer from the University of Minnesota in 1923. He entered the water supply field in 1937, when he accepted his present position. An AWWA member since 1946, he has served the North Central Section (formerly Minnesota Section) as trustee, vice-chairman, and chairman. He is also a member of the Minnesota Federation of Engineering Societies.

**Ohio—Donald D. Heffelfinger**, engineer-superintendent, Dept. of Water & Sewage, Alliance, Ohio. Born in Kenton, Ohio, in 1911, he received a B.S. from Mount Union College in 1933 and is a registered professional

North Central—  
CoultOhio—  
Heffelfinger

(Continued on page 48 P&amp;R)

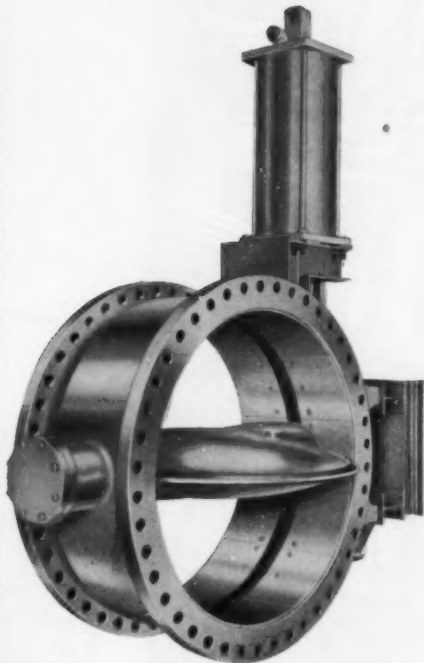
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Write for Bulletin 574  
on AWWA Valves



W. S. Rockwell Butterfly Valves offer advanced design and rugged construction. Made in all standard sizes of cast iron, cast steel, stainless steel, bronze or other alloys; natural or synthetic gum rubber seat with clamping segments, or spool type rubber liner extending over flange faces. Operators—manual: AWWA nut, handwheel, chain wheel or other types; automatic: electric motor or cylinder.

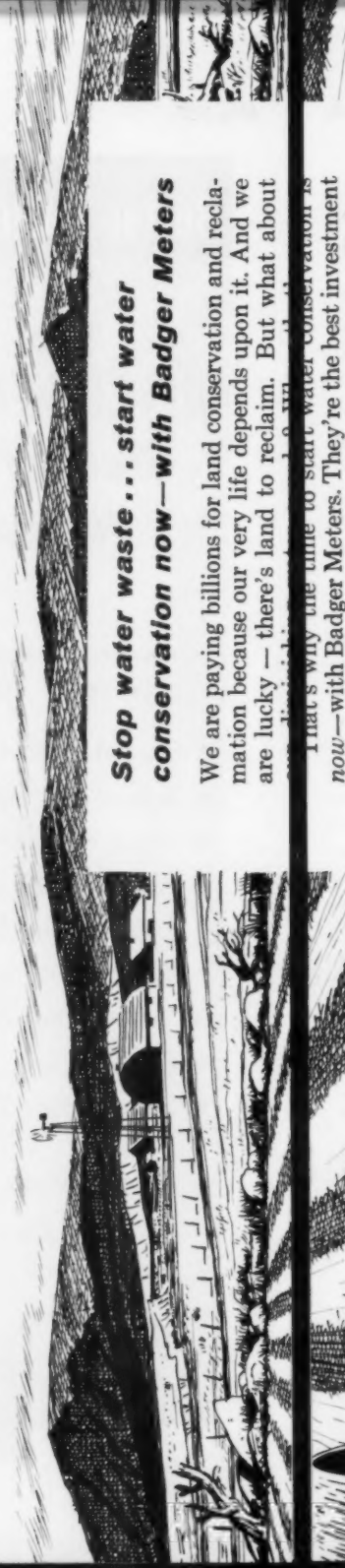
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We are paying billions for land conservation and reclamation because our very life depends upon it. And we are lucky — there's land to reclaim. But what about

That's why the time to start water conservation is now—with Badger Meters. They're the best investment

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That's why the time to start water conservation is now—with Badger Meters. They're the best investment you can make for your community's future. Badger Meters replace impractical and unjust flat rates with a fair-share, fair-pay program for everybody. Accurate metering proves to consumers that the best things in life are far from free. *That's* when water waste stops — conservation begins. What's more, Badger Meters put your water system on a profitable, business basis.

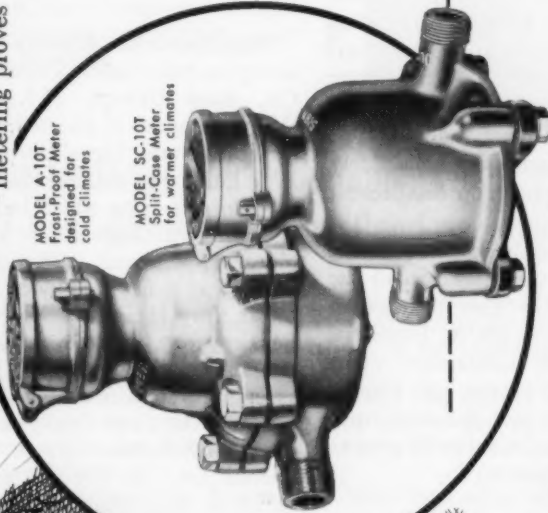
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# Badger Water Meters

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(Continued from page 44 P&amp;R)



**Southwest—  
Hoefle**



**Manufacturer—  
Howe**

engineer in Ohio. In 1933 he accepted the post of chemist at the Alliance Sewage Treatment Plant, becoming assistant superintendent in 1938 and superintendent in 1939. In the latter year he became chemist of the city's water purification plant, and in 1944 he was named director of public safety and service. He took up his present position in 1945.

An AWWA member since 1941, he has been trustee and chairman of the Ohio Section. He also belongs to FSIWA, Ohio Sewage & Industrial Wastes Treatment Conference (past chairman), Ohio Society of Professional Engineers (past chairman, municipal section), and Canton Engineers Society (past president).

**Southwest—Karl F. Hoefle**, consulting engineer, Forrest & Cotton, Dallas, Tex. Born in Fort Worth, Tex., in 1891, he holds a B.S. in civil engineering from Texas A&M (1912) and is a registered professional engineer in that state. From 1912 through 1923 he was engineer and superintendent of development for Oriental Consolidated Mining Co., Unsan, Korea. From 1924 to 1955 he served the city

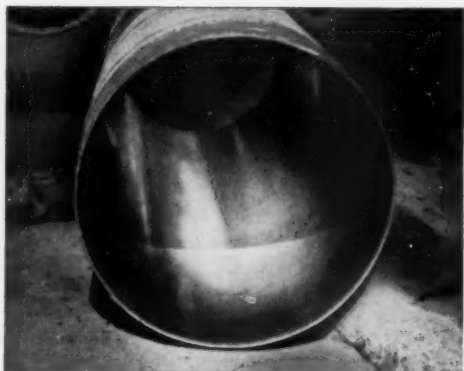
of Dallas as resident engineer on water works construction (until 1933), superintendent of street paving and maintenance (until 1936), Water Dept. distribution engineer (until 1945), and Water Dept. superintendent (until June 1955).

An AWWA member since 1940, he has been vice-chairman and chairman of the Southwest Section. He is also a member of NSPE, ASCE, Texas Water Conservation Assn. (past director), and Texas Water & Sewage Works Assn. (honorary life member).

**Manufacturer—Harvey S. Howe**, vice-president—sales, Lock Joint Pipe Co., East Orange, N.J. Born in Wagon Mound, N.M., in 1900, he saw service with the Signal Corps in World War I and then entered the University of Colorado, from which he was graduated in 1925 with a B.S. in civil engineering. From 1925 to 1928 he worked as a field engineer with Pito-meter Co. He joined Federal Water Service Corp. in 1928, first as a project engineer in New York City, later as engineer and chemist in the Pennsylvania Div., and finally as chief engineer of Scranton-Springbrook Water Service Co. In 1942 he entered the Office of War Utilities, War Production Board, and was deputy director of the Water Div. when he resigned in 1945 to become assistant vice-president of Lock Joint. While there, he has also served the US Dept. of Commerce in various capacities.

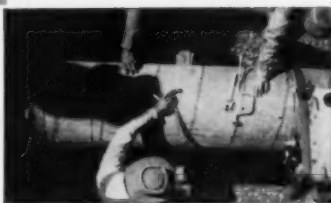
An AWWA member since 1939, he has been on the board of governors of the Water & Sewage Works Manufacturers Assn. since 1952 and was its president in 1955.

(Continued on page 50 P&amp;R)



Unretouched photograph of Armco Pipe after 17 years in water line service.

When this section of the 17-year-old Armco Pipe was uncovered, coating on the exterior showed practically no sign of deterioration.



## Spartanburg, South Carolina, Finds 17-Year-Old Armco Pipe Good as New

In 1939, the city of Spartanburg, South Carolina, installed 40,000 feet of Armco Welded Steel Pipe for a water line. In 1956, contractors removed a 5½-foot section of the 17-year-old pipe to insert a tee connection.

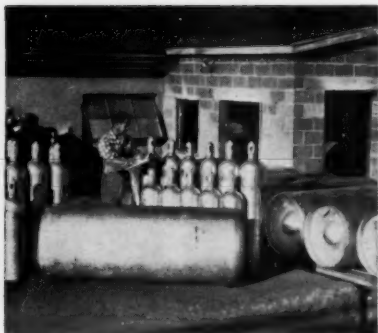
The unearthed section (shown above) still had its original smooth lining. In 17 years there had been *no loss of flow capacity*. The pipe line is good for many, many more years of dependable service.

You will find that Armco Pipe offers you many other advantages. It is supplied in a wide range of diameters, from 6 to 36 inches; wall thicknesses from  $\frac{9}{64}$  to  $\frac{1}{2}$ -inch; lengths up to 50 feet. Coatings are supplied to AWWA specifications.

Write for prices and delivery time. Armco Drainage & Metal Products, Inc., Welded Pipe Sales Division, 4827 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario.

### ARMCO WELDED STEEL PIPE





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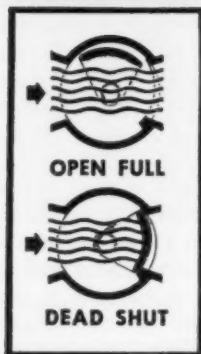
(Continued from page 48 P&R)

**Editors' Anomalies** is not a typographical error, but a title for those offbeat items that Editors Anonymous occasionally include in their contributions to P&R. Such was the news of a 1957 decrease of 25 per cent in water rates to the customers of the South Farmingdale, N.Y., Water Dist., where apparently the old flat rate of 20 cents per \$100 of assessed valuation was a fat rate. Such, too, was the news from the Illinois water survey that the well recharge program had last year resulted in a rise in ground water levels despite the 5½-in. rainfall deficiency. And such, especially, was the report last March that local water rates led the list of nongoods priced by the federal government in their increase since 1952, with a rise of 35 per cent. Even the label "nongoods" or the fact that upon nongoods rather than goods or foods was placed the blame for the recent rise in living costs hardly dampened our spirits. Down, we can agree, with mortgage interest, up 30 per cent in the same period; down with radio-TV repairs, up 25 per cent; down with movie admissions, up 20 per cent; down even with haircuts, up 14 per cent; but up and UP with water rates, until the basic anomalousness of their position in the price scale is corrected.

**Dorr-Oliver Inc.** has announced plans for a major expansion and reallocation of its United States production facilities, involving centralization of all domestic filter manufacture at the already expanding Hazelton, Pa., plant, as well as conversion of facilities at the Oakland, Calif., plant. Further expansion is also planned for the Dorr-Oliver-Long plant at Orillia, Ont.

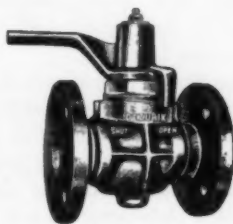
(Continued on page 52 P&R)

# NO LUBRICATION... NO FRICTION... NO LEAKAGE WITH DeZURIK <sup>EASY</sup> OPERATING PLUG VALVES



DeZurik's exclusive eccentric principle guarantees easy operation without lubrication. The plug is pivoted eccentrically in the valve and touches the valve seat *only* when the valve is closed. Opening the valve swings the plug back away from the valve seat and the valve opens wide with an easy quarter turn.

The resilient plug-facing of DeZurik Valves assures tight shut-off despite solids in the flow. On raw water inlet, sand filter intake (discharge and backwash), structure drainage discharge and many other services, DeZurik Valves perform with equal excellence.



DeZurik Valves are available in sizes from 1/2" thru 20", for manual or remote operation. Representatives in all principal cities. For details, write to



**DeZURIK**  
**CORPORATION**  
SARTELL, MINNESOTA.

(Continued from page 50 P&amp;R)

An exprex will become an exprof next month when Abel Wolman retires as professor of sanitary engineering at Johns Hopkins University. Not only an exprex of AWWA, Abel's list of services and honors from the time of his joining in March 1918 reads like a full review of what the Association has to offer: *Editor* '22-'37. *Diven Medal* '37. *Director* '39-'42, '43-'44. *Vice-Pres.* '42. *President* '43. *Honorary M.* '48. *Fuller Award* '52. *Jordan Achievement Award* '52. *Management Div. Award* '56. And having served since its formation in 1935 as chairman of the Association's National Water Policy Committee, he continues to do a most important job for the Asso-



ciation and the industry. Certainly all who know or know of Abel will understand why we're particularly proud that his first work with AWWA was with the JOURNAL.

In Abel's retirement, it is likely that only Johns Hopkins will recognize the change, for in his work as a member of the AEC's Reactor Safeguard Committee and its Safety and Industrial Health Advisory Board, as chairman of the board of consultants to Israel's National Water Planning Board, as consultant to Baltimore's Dept. of Public Works, the US Public Health Service, the Tennessee Valley Authority, Bethlehem Steel Co. (Sparrows

Point), Assn. of American Railroads, US Geological Survey, West Virginia Pulp & Paper Co., and the Interstate Commission on the Potomac River Basin, and his activity on ten different standing committees of various associations and governmental agencies, he is unlikely to have any more time for his slippers and easy chair than before.

In an appreciation of Abel's career at the 65-mile post, *Engineering News-Record* has been particularly perceptive in recognizing his value as a "pointer of the way" and an urger on to bigger things. His work in AWWA and his articles in the JOURNAL have demonstrated that genius as well as his uncommon facility in the use of language. At the moment, Abel is turning these talents toward two major concerns: the safe disposition of radioactive "garbage," which he discusses in the lead article of this issue (p. 505); and the convincing of water works men that "the public is entitled to all the water it wants and will pay for, short of truly wasteful uses," for which we could kiss him. Having been rather buffeted on the impracticality of our idea that the water works field should aim to provide the public with "all the water it needs, when and where it needs it," we can take heart at finding such an ally. "The situation," he has said, "will not be met by bemoaning privately the extraordinary habits of the American people and by resisting to the last ditch their insistence to be permitted to use water for purposes which they prefer."

Having read his summation of the radioactive-garbage problem and having experienced some of the resistance to the "all the water" idea, we are certain that Abel's retirement could be more than full even if he were to give up all his official activities in favor of

(Continued on page 96 P&amp;R)



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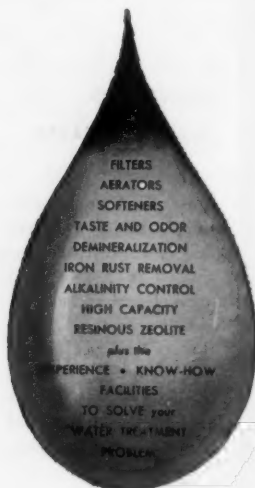
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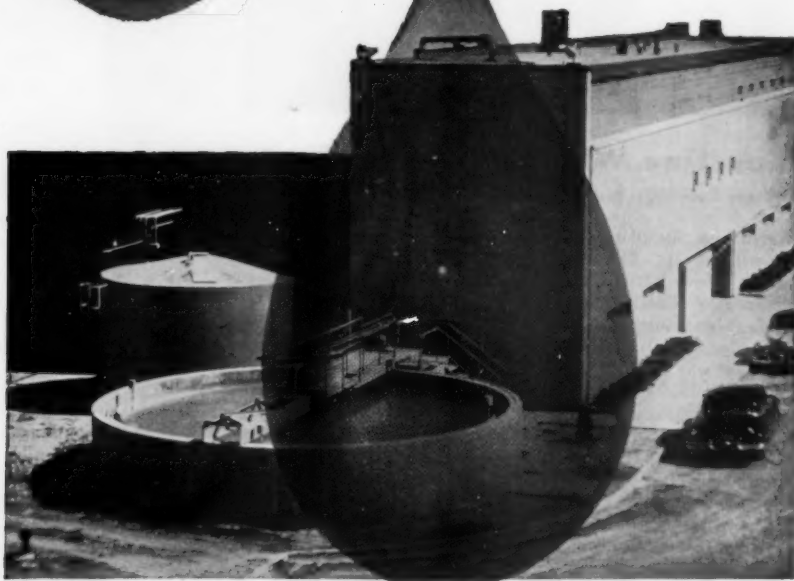
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## Condensation

**Key:** In the reference to the publication in which the abstracted article appears, 39:473 (May '47) indicates volume 39, page 473, issue dated May 1947. If the publication is pagged by the issue, 39:5:1 (May '47) indicates volume 39, number 5, page 1, issue dated May 1947. Abbreviations following an abstract indicate that it was taken, by permission, from one of the following periodicals: *BH*—*Bulletin of Hygiene (Great Britain)*; *CA*—*Chemical Abstracts*; *Corr.*—*Corrosion*; *IM*—*Institute of Metals (Great Britain)*; *PHEA*—*Public Health Engineering Abstracts*; *SIW*—*Sewage and Industrial Wastes*; *WPA*—*Water Pollution Abstracts (Great Britain)*.

### AQUATIC ORGANISMS

**The Phytoplankton of Great Pond, Massachusetts.** E. M. HULBURT. *Biol. Bul.*, 110: 157 ('56). During 1950, survey was made to det. concns. of phytoplankton in Great Pond, small shallow estuary near Falmouth, Mass. It was found that, particularly in summer, concn. of phytoplankton was greater within Great Pond than in sea water at its entrance. During autumn, winter, and spring, same species were found in pond and in sea, but in summer number of species occurred within pond which were not present in sea and are not characteristic of river water. In summer flora in pond contained large proportion of flagellates, while flora in sea water was composed entirely of diatoms. Preponderance of motile forms within pond in summer is attributed to good growth conditions, which stimulated endemic flora, and to quiet shoal water, which should favour non-settling type of cell.—*WPA*

**The Estimation and Characterization of Plankton Populations by Pigment Analysis. III. A Note on the Use of "Millipore" Membrane Filters in the Estimation of Plankton Pigments.** G. I. CREITZ & F. A. RICHARDS. *J. Marine Research*, 14: 211 ('55). Technique is described for use of aerosol-assay type Millipore membrane filters instead of centrifugation in method of Richards and Thompson for estg. plankton pops. by pigment anal. It is shown that dissolution of membrane filters in 90% acetone used to extract pigments does not interfere with spectrophotometric detn. of chlorophyll and carotenoid components. Retention of plankton by membrane filter and Foerst centrifuge techniques are compared. Subsequent membrane filtration of material passed by centrifuge showed that centrifuging gave markedly low est. of chlorophyll *c* and slightly low estimate of

chlorophyll *b*. Results of comparison of techniques are tabulated, and discussed in relation to estn. of plankton pops. by pigment anal.—*WPA*

**The Ecology of the Zymogenic Planktonic Bacterial Flora of Natural Waters.** H. W. JANNASCH. *Arch. Mikrobiol. (Ger.)*, 23: 146 ('55). Author describes investigations into morphology of bact. flora of different types of natural waters by direct method of examn. of quant. and form. Information on degree of trophism of water can be obtained not only from bact. number but also from forms present. Samples of very different types of water but with equal contents of nutrient matter show very similar bact. pops. Study was made of phenomenon of adsorption. Distr. of bacteria in water varies with distr. of nutrient matter between solid particles and free water, and is more homogeneous greater the content of dissolved org. matter in water. Formation of poverty forms and effect of content of nutrient matter on metabolism were studied.—*PHEA*

**Aquatic Macro-Invertebrate Communities as Indicators of Organic Pollution in Lytle Creek.** A. R. GAUFIN & C. M. TARZWELL. *Sewage and Ind. Wastes*, 28:906 ('56). Distr. and abundance of bacteria, protozoa, and algae in Lytle Creek were largely detd. by nutrients and predator-prey relations. Approx. 99% of coliform bacteria in stream below sewage outfall were contributed by sewage. In first 2 mi. of stream below outfall, coliforms and enterococci decreased, whereas total bact. pop. increased. *Zoogloea*, *Sphaerotilus*, and certain protozoa were most abundant in section immediately below sewage outfall while poln.-tolerant blue-green algae increased progressively in polls for distance of 2 mi. downstream with diatoms reaching their peak below this section. Seasonal diurnal changes were great

(Continued on page 64 P&R)

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(Continued from page 62 P&amp;R)

and were most marked in recovery zone. Diurnal fluctuations in D.O. and pH were greatest in late spring and early summer. Little reliance can be placed upon mere occurrence of single species in given locality. In Lytle Creek 9 species characteristic of septic zone also occurred in recovery and clean water zones, but in much smaller numbers. Distr. and number of species and individuals in septic zone differed greatly from that in clean water areas. Septic zone had less than  $\frac{1}{3}$  as many species as clean-water zone, but number of individuals of each species and total number of organisms per unit area were many times greater. Septic zone was characterized by species adapted to live under low D.O. conditions (less than 1 ppm) as *Tubifex* and *Limnodrilus*, or those able to secure their oxygen directly from air as do *Culex pipiens*, *Eristalis bastardi*, and *Physa integra*. Hemiptera and Coleoptera were found in septic zone, but these were also equally numerous in other zones. Modification of their tracheal system and general body surface which increases internal air capac. of the tracheal system and enables them to use ext. air stores which serve like physical gills, enabled them to withstand very low D.O. levels (7 to 0.5 ppm), and made their mere presence poor indicator of D.O. content. Community of organisms most characteristic of avg. conditions in the recovery zone consisted of lesser numbers of species found in septic zone plus variable numbers of more tolerant forms found in clean water, especially those having variety of methods for securing oxygen. These included certain larvae of the blackfly, *Simulium vittatum*; midge, *Tanytus stellatus*; and caddis fly, *Cheumatopsyche* sp.; and nymphs of mayfly, *Callibaetis* sp., and dragonfly, *Libellula lydia*. Clean waters were characterized by great variety of invertebrate communities consisting of herbivores, carnivores, and omnivores; prey and predators; lung, tracheal-tube, and gill breathers. In general pop. contg. abundant gill-breathing forms, mayflies, stoneflies, and caddis flies was indicative of clean water conditions and their absence denoted presence of poln. and/or low oxygen.—PHEA

**Algae of the Eastern Bernese Oberland.** E. MESSIKOMMER. Mitt. Naturforsch. Ges. Bern., 13:81 ('56). Mainly listing of fresh-water algae encountered. Phys. and chem.

compn. of some lakes and ponds are discussed. Anal. of water of Blausee at Kandergrund is given; it is high in Ca, Mg, and SO<sub>4</sub>.—PHEA

**Stream Enrichment and Microbiota.** J. B. LACKEY. Public Health Rep., 71:708 ('56). In comparative studies of 3 streams in U.S., quant. and qual. detns. of suspended algae and protozoa provided specific evidence of fertilizing effects of treated sewage effluent on some species of these organisms. In Lytle Creek, small stream in southwestern Ohio which receives effluent from primary sewage treatment plant, total of 167 species were found. Certain species of Euglenophyceae were exceptionally abundant at points below plant outfall. Chlorophyceae and Chrysophyceae were adversely affected by effluent. Of 92 species of microbiota in Cowan Creek, similar but unfertilized stream in same area, only Chrysophyceae and diatoms (Bacillarieae) were abundant.—PHEA

**A Qualitative and Quantitative Study of the Plankton Algae in Southwestern Georgia.** G. J. SCHUMACHER. Am. Midland Naturalist, 56:88 ('56). Purpose of this survey was to present qual. and quant. study of plankton algae of Southwestern Georgia. Qual. collections were limited only by boundaries of 11 counties, whereas qual. samples were restricted to 15 ponds. 15 mo. were spent in field gathering necessary material. Total of 399 species and varieties, 93 genera and 31 families was determined. 207 species represent new records for state of Georgia and 85 species are reported for first time for Southeastern Coastal Plain. Some of more noteworthy finds are *Chrysopyxis bipes*, *Coelastrum chodosi*, *Dinobryon divergens*, *Paridinium limbatum*, *Phymatodocis nordstedtiana* and *Pleurotaenium spinulosum*. Genera represented by largest number of species are as follows: Cosmarium, 43; Staurastrum, 41; Closterium, 29; Euastrium, 23; Micrasterias, 23; Scenedesmus, 15. Families with largest number of species are the following: Desmidiaceae, 211; Oocystaceae, 34; Chroococcaceae, 23; Scenedesmaceae, 18; Oscillatoriaceae, 15. Babcock Pond had richest flora with 114 species of plankton algae. Those ponds approaching this number are Big Bypress, 111; Cane Water, 93; Putney, 89; Mossy, 88 and Porter, 88. 2 mill ponds, Sheffield's and Ivy's, had lowest

(Continued on page 66 P&amp;R)

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The three De Laval turbine-driven centrifugal pumps (shown above) have given dependable service in the Howard Bend Station of the St. Louis, Mo. water works system for more than a quarter of a century. The two smaller units have a capacity of 60 mgd and the larger one of 120 mgd, all designed to deliver against 40 ft. head.

In the St. Louis Chain of Rocks Station, De Laval pumps have an even longer service record. Two 40 mgd units were installed in 1912 and a 100 mgd unit in 1918. Two of these three pumps are still on the line. The third has been altered and is still in constant service.

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### DE LAVAL Centrifugal Pumps

DE LAVAL STEAM TURBINE COMPANY

822 Nottingham Way, Trenton 2, New Jersey

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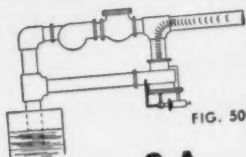


FIG. 500-A

with the **G-A**  
**ANTI-SURGE VALVE**  
Bulletin W-16

## Relieve Surge



FIG. 66-D

with the **G-A**  
**SURGE RELIEF VALVE**  
Bulletin W-2

## Prevent Surge

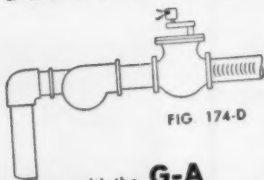


FIG. 174-D

with the **G-A**  
**ELECTRIC CHECK VALVE**  
Bulletin W-10

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**ANDERSON**  
*Valve Specialty Company*

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**VALVES FOR AUTOMATION**

(Continued from page 64 P&amp;R)

number with 29 and 32, respectively. Qual. findings are presented in annotated list, while quant. results are recorded graphically by mo. for each pond. Blooms of *Dinobryon divergens* and *Microcystis aeruginosa* were noted during winter and summer mo., respectively. Attempt was made to classify ponds on basis of number and variety of algae found therein, with particular emphasis placed on Desmidiaceae. This resulted in establishment of 3 groups. Group 1 was characterized by having limited quant. numbers of algae, rather even seasonal distr. and wide variety of species, especially among desmids. Second group likewise possessed large variety of desmid species but had phytoplankton pop. which was generally rich in numbers and exhibiting marked seasonal pulsations. Final group has intrinsic property of being desmid-poor while having relatively high numbers of diatoms and blue-greens. Members of group 3 had clear cool waters and sandy bottoms whereas those ponds in groups 1 and 2 had warm dark waters and mucky organic bottoms.—PHEA

**General Features of Algal Growth in Sewage Oxidation Ponds.** M. B. ALLEN. Calif. State Water Pollution Control Bd. Publ. No. 13 ('55). Studies have shown that unicellular green algae, *Chlorella* and *Scenedesmus*, are important on operation of pilot-scale sewage oxidation ponds. These algae do not grow on sewage in dark and do not reduce content of oxidizable matter. Max. algal crop which can be grown on domestic sewage is 1-2 g (dry weight)/l. Stage of oxidation is indicated by algal flora. During active oxidation, *Chlorella* is present, and this is followed in later stages by *Scenedesmus* and *Chlamydomonas*. Large ponds operate satisfactorily under wide variety of conditions, and are mainly self-regulating. For max. algal growth, supplementary carbon and nitrogen are necessary.—WPA

## POLLUTION CONTROL

**Industrial Pollution Control. Part II—The Problem as it Affects Industrial Management.** R. F. WESTON. Industrial Wastes, 1:170 ('56). It is estimated that, to date, industry in United States has spent over \$1 billion for water poln. abatement and, within next 10 yr, will spend additional \$4 to \$5 billion for this purpose. Public

(Continued on page 68 P&amp;R)



# Water Testing

\*APPROVED Water Pollution Control Technique

*in the Field*

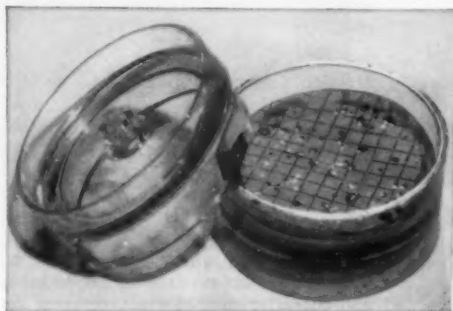
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SUPPLIED STERILE and ready for use, the FIELD MONITORING KIT contains two disposable plastic Monitor units which serve as combination filter holders and culturing dishes, two ampules of liquid nutrient medium, and two plastic sampling tubes. The Kit is packaged in a convenient mailing box to allow easy shipment if desired.

THE FIELD MONITORING KIT allows the sampling of large volumes of water, eliminates the cost and

inconvenience of sample shipments in glass bottles, and requires no laboratory facilities. It is FAST, ACCURATE, REPRODUCIBLE AND ECONOMICAL.



FIELD MONITOR top removed to show Coliform Bacteria Sheen Colonies developed on the MF® surface after 18 hours of incubation.

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### WATER TESTING IN THE FIELD — IN EIGHT STEPS



1. Cup thoroughly rinsed



2. Sample drawn through Monitor in inverted position



3. Monitor righted for last drops



4. Ampul top broken — ampul inserted into Monitor



5. Ampul top broken — ampul lifted slightly



6. Media drawn through Monitor with syringe. STOP THE INSTANT last few drops of media disappear.



7. Replace caps.



8. Incubate 20 hours in inverted position



## MILLIPORE FILTER CORPORATION

36 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS, U.S.A.

(Continued from page 66 P&R)

demand for clean streams; increasing need for clean water for domestic water supply, industry, agriculture and recreation; and continued increase in poln.—all indicate that poln. control will become an increasingly important item for industrial concern. It will be in best interests of industry to voluntarily undertake surveys of its wastes and institute policies that will abate poln. Its activities in this field will result in prosperous business through good public relations; prevention of losses from forced shut-downs, costly lawsuits, or claims for damages; and reduction of losses caused by lowered water quality.—PHEA

#### **Natural Sediments as a Factor in Stream**

**Pollution Control.** R. D. HOAK & H. C. BRAMER. *Sewage and Ind. Wastes*, 28:311 ('56). 3 methods are presented for estimating load of suspended solids in streams. Method to be used will depend on quant. and qual. of available data, location for which information is desired, accuracy required and time allowed to get information. Where there are no data on suspended solids and characteristics of drainage areas do not differ greatly from those in Ohio and Delaware river basins, Eq. 8 may be used to estimate sediment loads. If location is in Ohio R. or Delaware R. basin, Eqs. 6 or 7 may be used. Where actual load data are available, full statistical method should be used to make precise ests. Example is given to illustrate effect of natural sediment on clarifier operation. It is proposed that regulations governing discharge of suspended inorg. solids be related to normal load of such material carried by receiving stream.—PHEA

#### **The Adverse Influence of any Type of Organic Matter on the Quality of Underground Water and the Ways and Means of Controlling Such Risks in Sweden.**

A. ULLERSTAM. *Vattenhygien (Sw.)*, 12:81 ('56). Underground water, important in Sweden's water supply, is usually found in coarse materials which do not obstruct penetration by foreign substances. Most serious poln. is by petroleum products from faulty ground storage tanks and by sulfite waste liquor used as a dust-binding medium on roads. Intrusion can be continuous and gradual, as it usually is with sewage, or

intermittent, as with petroleum products. Although sewage contmn. can be controlled with chlorination, petroleum contmn. may destroy water source. Practice of providing protected areas for wells is increasing, and 1940 water law provides fines for disregarding prohibitive protective measures. It also sanctions limitations of adjacent properties (with compensation to owners) where necessary to carry out protective measures. Public Health Law empowers municipal health depts. to establish protective measures for respective communities. Measures, however, are unsatisfactory because of difficulty of enforcement and because enforcing authority is not clearly delegated. Protection can be improved by more stringent and specific legislation. Allowable extent of encroachment of private property (where protective measures necessitate it) should be stated and limits of legally protected areas clearly defined. Use and storage of dangerous substances should be carefully controlled as should excavation and placement of gravel pits and disposal of sewage. Studies of rates of spread of contmn., of survival of bacteria, and of techniques of purif. following contmn. are valuable. A coordinated investigation of whole problem on international level is needed. 22 examples of contmn. in Swedish communities are given.—Ed.

#### **Water Pollution-Magnetic Abatement.**

W. R. STEMEN. *Tech. Assoc. Pulp Paper Ind.*, 39:255 ('56). In method which has been devised for clarification of white water from paper factories, white water is mixed rapidly with coagulant and ferromagnetic powder. Mixture is agitated gently to promote floc formation, and floc is then removed in revolving drum contg. stationary magnet which attracts floc to surface of drum. Pilot-plant studies gave reductions in B.O.D. of 30-50%, in total suspended solids of 60-70%, and in settleable solids of 90%. Vol. of sludge produced is about 65% of vol. produced by gravity sedimentation. It is now planned to operate a full-scale magnetic drum, at rate of 250 gpm. This method is not suitable for recovery of fibers, and cost of chem. is slightly higher than for conventional treatment methods, but advantages are compactness of the equip. and speed at which treatment is completed.—PHEA

(Continued on page 72 P&R)



For new Big Walnut 50-MGD project...

Aerial view of Big Walnut plant. Built for City of Columbus, Ohio—Floyd C. Redick, Director, Department of Public Service; Paul C. Laux, Superintendent of the Division of Water. Uhlman Associates were the consulting engineers for design and construction.

## Columbus, Ohio selects Leopold Filter Bottoms, Operating Tables and Carbon Slurry Agitators

Built at an approximate cost of \$5,750,000, the Big Walnut project is designed to provide adequate water supply capacity to meet the ever-increasing needs of the City of Columbus. The new, modern facilities (shown above) have a nominal capacity of 50 mgd, a maximum rated capacity of 73 mgd, and are equipped with twelve Leopold five-valve operating tables, six Leopold carbon slur-

ry agitators, and twelve sets of Leopold glazed tile filter bottoms.

Like this new project, more and more water treatment plants are using Leopold equipment—whether for new construction or modernization programs. It will pay you big dividends to do the same! For details on Leopold water purification and filter plant equipment, write today. There's no obligation.



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# NEW SIMPLEX ELECTRONIC PROGRAMS FILTER WASING

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From one central point, filtering and washing cycles can be initiated automatically . . . all rates and times maintained accurately. Valve action is completely pneumatic! The system contains no electrical devices that might malfunction in the dampness of a wet pipe gallery.

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This new system automatically shuts off a filter if the clearwell is filled—returns it to service when needed. Depending on the control you prefer, a filter will be automatically removed from service for backwashing when (1) loss of head reaches cut-off point you pre-set (usually 8') or (2) electric timer has run through the value you pre-set (80 to 120 hrs.). At any point, the operator can manually over-ride these automatic controls.

### No-Flood Washing

When automatic program starts, the filter Influent Valve is closed, water level drops to wash-trough lips, then the filter Effluent Valve is closed.

Next the Drain Valve is opened followed by the Wash-Water Valve. Pneumatic interlocks prevent flooding: wash valve can't open until drain valve is fully open.

Washing is precisely timed at fast-slow rates . . . so bed is cleaned and hydraulically graded for optimum results.

### Saves Treated Water

To prevent flooding, Drain Valve can't close until all Wash Water have first closed. To prevent loss of treated water, filter Influent Valve can't open until drain valve has completely closed. Washing period can be extended, if desired.

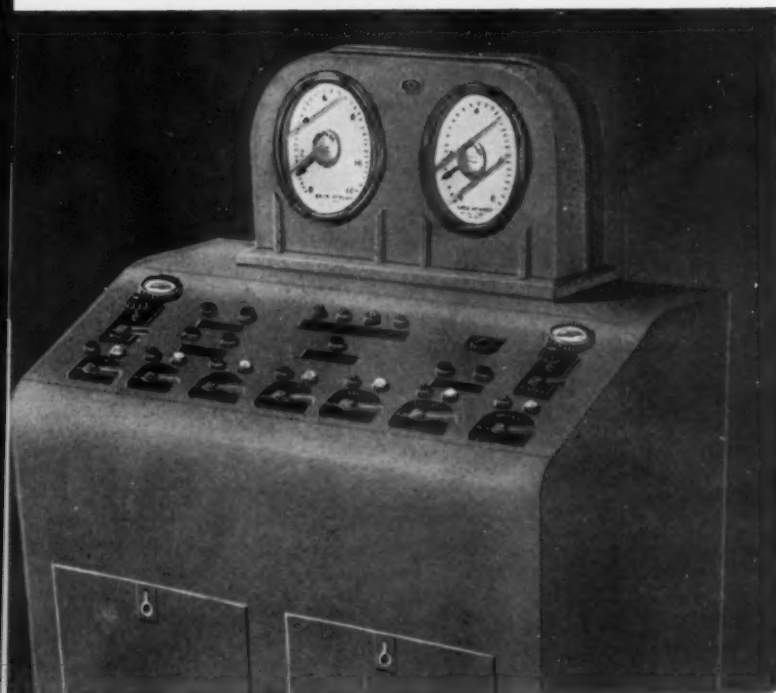
### Controlled Starts

To prevent turbid starts, when Influent Valve is opened, the Effluent Valve stays closed until water reaches operating level. Float switch then opens Effluent Valve.

### No Sequence Errors

Cascade programming makes mistakes impossible. All valves operate close in their proper sequence.

# RONEUMATIC SYSTEM ASNG AUTOMATICALLY



**NEW SIMPLEX AUTOMATED FILTER TABLE:** Large dials indicate and/or record rate of flow and loss of head. Smaller dials set filtration and wash rates. Colored lights show progress of the automatic cycle. Manual levers permit operator to over-ride the automatic programming at any point.

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(Continued from page 68 P&amp;R)

**Pollution of Surface Water in Europe.**

A. KEY. Bul. World Health Organization, 14:845 ('56). This long paper deals primarily with problems confronting western European countries as regards surface water and its poln. Meaning of poln. as used in this paper is defined: river is considered to be poln. when water in it is altered in compn. or condition, directly or indirectly as result of activities of man, so that it is less suitable for any or all purposes for which it would be suitable in its natural state. It is to be noted that this definition would include as poln. any artificial increase or decrease in temp. if that interfered with use of water. General problems of poln. of surface waters in Europe are described, after which great deal of particularized information is given of conditions in 18 countries of Europe concerning area and pop., physical features and rainfall, sewerage and water supply, degree and type of industrialization, condition of rivers and estuaries, use made of rivers for bathing, fishing and

agriculture, river authorities, powers of poln. prevention, sewage treatment, industrial wastes disposal, tests for river qual. and existing research authorities. These individual accounts, though brief, show clearly great variations which exist in types and intensity of water poln. problems in Europe. These problems are thoughtfully discussed. Water poln. in Europe is sufficiently severe in some countries to constitute urgent national problem; in others it is primarily of local importance only; and in few it hardly exists. But in almost all countries where poln. is already severe it is recognized that matter requires urgent attention, and most are making strenuous efforts, within limits of their resources, to deal with it.—BH

**Pollution of Ground Water in Europe.**

S. BUCHAN & A. KEY. Bul. World Health Organization, 14:949 ('56). This report on poln. of ground water in Europe is the natural complement to preceding article on surface water poln. It gives much information

(Continued on page 74 P&amp;R)

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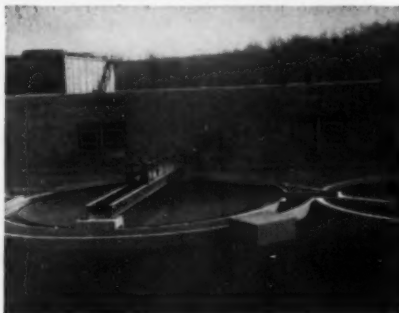
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(Continued from page 72 P&amp;R)

obtained from 20 countries of European region in reply to questionnaire sent out by World Health Organization regional office for Europe. Data are recorded under headings of geology and hydrogeology, water supply, poln., methods of purification, control and legislation. Much polg. matter of various types occurs, or is placed, on surface in Europe in circumstances where it can percolate downwards to ground water. Geological and other phys. conditions will then determine whether or not ground water is rendered unsafe or unsuitable for use. Whole subject is described and discussed with reference to some exptl. investigations which are being conducted.—BH

**Pollution of the Aare Between the Bielersee and the Rhine.** K. SAUER. Gas- u. Wasserfach, 96:120 ('55). Results are discussed of a chem. examination of a 120 km stretch of the Aare and use of water for bathing, industrial supply, and supplementing ground water is considered. Investigation shows the necessity for mechanical treatment of all waste waters and for biol. treatment of waste waters discharged to tributaries with low water flows.—WPA

**Pollution of Rivers by Phenolic Waste Waters.** K. VIEHL. Gas- u. Wasserfach, 96:105 ('55). Author describes problem of discharge of phenolic waste waters to German rivers, with special reference to the Pleisse which in recent years has been heavily pold. above Leipzig by waste waters from works using distn. and hydrogenation processes for production of benzene from brown coal. Data are then given of composition of waste waters containing phenol

from treatment of coal and from other industries using phenol, such as manufacture of plastics. Effect of phenol and of different waste waters containing phenol on fish and other organisms and on selfpurifying cap. of water is then discussed with special reference to the pold. stretch of Pleisse above Leipzig. Brief accounts are then given of various methods possible for extraction or destruction of phenol in waste waters and conditions for which different methods are suitable.—WPA

### CHEMICAL ANALYSIS

**Indicator for Titration of Calcium in Presence of Magnesium Using Disodium Dihydrogen Ethylenediaminetetraacetate.** H. DIEHL & J. L. ELLINGBOE. Anal. Chem., 28:882 ('56). New indicator has been developed for use in detn. of calcium with disodium dihydrogen ethylenediaminetetraacetate in presence of magnesium. Indicator, called calcein, is prepared by condensing imino-diacetic acid with fluorescein. It is necessary to carry out titration at pH 12, at which value indicator is brown and its calcium complex is yellow-green. At lower pH values color of free indicator is also yellow-green. Magnesium does not form complex with indicator, but excessively high concns. of magnesium and sodium cause results to be slightly low. Copper and iron interfere, but this can be prevented by addition of cyanide.—WPA

**New Indicator for Titration of Calcium With (ethylenedinitrilo) Tetra-acetate.** J. PATTON & W. REEDER. Anal. Chem., 28:

(Continued on page 78 P&amp;R)

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Many large industrial and municipal plants are now saving money on salt deliveries, on salt handling, and on brine production—simply by installing a Storage Lixator. An exclusive development of International Salt Company, the Storage Lixator is basically a large combination salt-storage and salt-dissolving tank.

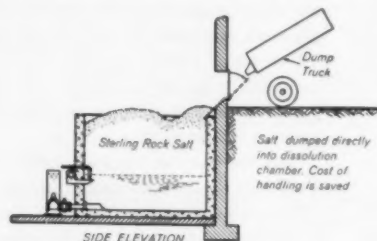
The Storage Lixator is strong—can easily hold the weight of heavy trucks or railroad cars. It's adaptable—can be located almost anywhere, either inside the plant or outside. It's fully automatic—continuously replenishes whatever amounts of brine are drawn off through the piping system to points of use. And it needs no maintenance.

**Another money-saving feature:** with the Storage Lixator, brine-storage tanks are rarely necessary. This is because International's Lixate principle, on which every Storage Lixator is based, makes use of "Wet Storage"—meaning that undissolved salt is stored in the same tank with saturated brine. Even when the Lixator is completely filled with salt, there is ample room between the salt crystals for storing fully saturated brine.

The operation of every Storage Lixator is basically the same, but there are many design

possibilities, by which International's Lixate principle can be adapted to any plant requirements. Here are some typical Storage Lixators, showing how they are engineered to meet specific needs.

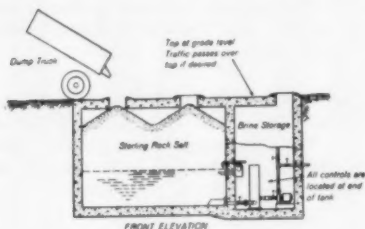
#### 1. The Inside Single-Compartment Storage Lixator . . . ideal for congested areas



where outside property is not available. Salt is dumped from a truck directly into the dissolving chamber (the Lixator is just inside the plant wall), and salt-handling costs are reduced. The Lixator controls are easily accessible from inside the plant.

**2. The Shed-Type Storage Lixator** is very practical for small-scale storage and dissolving operations when space is available adjoining the plant building. Large doors permit easy salt entry by portable conveyor belt fed directly from a dump truck or railroad car. With this setup, any available space can be used for an inexpensive brine-making unit inside the shed.

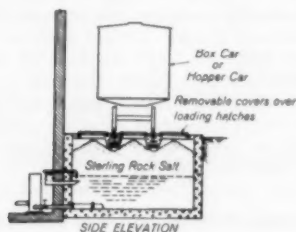
### 3. The Integral Brine Tank Storage Lixator . . . one of the best for operations



which require large amounts of fully saturated brine only at certain times. (The brine-storage tank included in the Lixator can be made as large as necessary.) Because the top of this Lixator is at ground level, traffic can pass over it—and delivery trucks can pour salt directly into the loading manholes.

**4. The Underground-Tank Storage Lixator** is a single-compartment rock-salt storage and dissolving unit which adjoins a railroad siding. With the top of the Lixator on the same level as the floor of the railroad car, salt delivery by power scoop, or portable conveyor belt is an easy operation. Fully saturated brine, made automatically in this Lixator, can be pumped any distance to the points of use.

**5. The Undertrack Dual-Unit Storage Lixator . . . popular with large salt users.**



It has been found that its relatively high installed cost is more than offset by the most inexpensive salt delivery method known today (and possible only with this undertrack design). A railroad hopper car passes over the Lixator, and salt drops directly into storage. No conveyor belt is needed, and salt delivery is entirely automatic.

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For example, through skilled and experienced "Salt Specialists," International can give you helpful information on modern regeneration techniques. This information has been developed as a result of International's extensive work on water softening in the chemical, textile, food-processing, and meat-packing industries.

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**INTERNATIONAL  
SALT CO., INC.,**

**SCRANTON 2, PA.**

(Continued from page 74 P&amp;R)

1026 ('56). New indicator, 2-hydroxy-1-(2-hydroxy-4-sulpho-1-naphthylazo)-3-naphthoic acid, has been developed for use in detn. of calcium with (ethylenedinitrilo) tetra-acetate in presence of magnesium. Indicator gives sharp stable color change from wine red to pure blue at end-point. Usual ammonia-ammonium chloride buffer is replaced by odorless monoethanolamine-hydrochloric acid buffer containing complexed magnesium. Detailed procedure is given for detn. of calcium and magnesium in water, limestone, salt, and boiler scale.—WPA

**Colorimetric Specific Method for Determination of Traces of Chlorine in Chlorinated Tap Water.** L. M. KUL'BERG & L. D. BORZOVA. J. Chim. Ukr. (U.S.S.R.), 22:100 ('56). Method for detg. traces of chlorine in tap water has been developed, based on formation of blue sodium indophenolate as result of action of chlorine on mixture of aniline and phenol in presence of sodium hydroxide. 2 modifications of method, for detg. concn. less than 1  $\mu\text{g}$  and more than 1  $\mu\text{g}$  per ml, are described. To det. concn. less than 1  $\mu\text{g}$  per ml, chlorine is concd. by extraction with chloroform and extract is treated with sodium hydroxide to form hypochlorite. No interference is caused by iron, manganese, nitrite, or other common ions.—WPA

**Diallyldithiocarbamido-hydrazine as an Analytical Reagent. I. Determination of Copper, Nickel, Zinc and Lead and Separations of Their Binary Mixtures.** N. K. DUTT & K. P. S. SARMA. Anal. Chim. Acta, 15:21 ('56). Use of diallyldithio-carbamido-hydrazine for quant. detn. of copper, nickel, zinc, and lead is described. Copper is prtd. at pH 2.5-3.5, lead at pH 5-6, zinc at pH 7.5-8.6, and nickel at pH 8-9. Complexes formed have definite chem. compns. and can be weighed directly in weighed crucible. Elements can be detd. individually and also in their binary mixtures after adjustment of pH values.—WPA

**Quadrivalent Uranium as a Reducing Agent in Potentiometric Titrations. II. Estimation of Dichromate, Permanganate, Bromate and Tellurate.** I. M. ISSA & I. M. E. SHERIF. Anal. Chim. Acta, 14:474 ('56). Use of quadrivalent uranium as reducing agent in potentiometric titrations has been

extended to detn. of dichromate, permanganate, tellurate, and bromate, either alone or in mixture also containing ferric, ceric, and vanadic ions.—WPA

**Simple Instrument for Titrimetry Without Visual Indicators. Gasometric Titrations. X. Cerimetry, Chlorimetry, Nitrate, Nitrite, Hydroxide and Carbonate Determinations.** O. R. GOTTLIEB. Anal. Chim. Acta, 13:531 ('55). Gas pressure technique for detn. of endpoint in titrimetric anal. where no visual endpoint can be obtained, has been further developed so that endpoint may be solved graphically by intersection of curves obtained by plotting gas vol. or pressure against vol. of titrant used. Descriptions are given of instrument used and of application of graphical method in cerimetric and chlorimetric titrations, and in detn. of nitrate, nitrite, hydroxide and carbonate; results obtained compared favorably with those given by conventional visual endpoint methods. Use of technique for quant. anal. of binary mixtures is discussed.—WPA

**Quantitative Determination of Ethylene Glycol in Water.** E. R. HESS, C. B. JORDAN, & H. K. ROSS. Anal. Chem., 28:134 ('56). Procedure is described for quant. detn. of ethylene glycol in water, based on time taken for silver iodate ppt. to appear after addition of nitric acid and periodic acid to mixture of sample and aqueous silver nitrate. A nomograph, constructed to facilitate calcn. of ethylene glycol concn., and data illustrating accuracy and reproducibility of method are given. Method may be used for rapid calcn. of large numbers of detns. of ethylene glycol in water, and may be applied to other substances with reasonable reaction rates; substances reducing periodate to iodate or pptg. silver iodate from acid solution interfere.—WPA

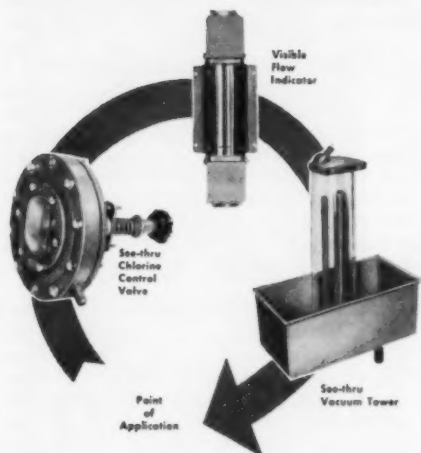
**Colorimetric Determination of Fluoride in Water by Heteropoly Blue System.** R. P. CURRY & M. G. MELLON. Anal. Chem., 28:1567 ('56). New method for detn. of fluoride in water utilizes distn. of fluoride as silicon tetrafluoride from sulfuric acid medium. Silicon tetrafluoride is carried by nitrogen gas steam into sodium borate-boric acid buffer and hydrolyzed, after which sol.

(Continued on page 80 P&amp;R)

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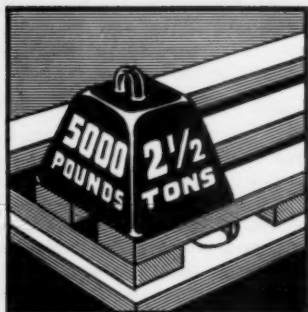
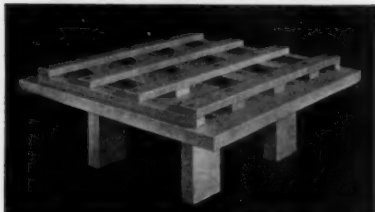
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# FILTRATION

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(Continued from page 78 P&R)

silicate is detd. by formation of molybdo-silicic acid and subsequent reduction to corresponding heteropoly blue. This method affords accurate and precise detn. of fluoride in range from 0.1 to 2.0 mg. Effects of following variables were investigated: presence of 25 diverse ions, distn. time, and water concn. on distn. system. Beer's law is followed from 0.1 to 2.0 mg. of fluoride with a standard deviation of 0.024 mg. Sensitivity of method is 0.18 absorbance unit per 0.1 mg. of fluoride.—PHEA

**Differential Spectrophotometric Determination of Fluoride.** J. J. LOTHE. Anal. Chem., 28:949 ('56). Differential method of anal. has been applied to indirect spectrophotometric detn. of fluoride with thorium-Alizarin Red S reagent at pH 2.8. Absorbance of sample soln. is taken against 1 of set of 3 reference standards containing 50, 100, and 200 µg of fluoride per 50 ml. Coefficient of variation of method is less than 1% for concns. of 50–200 µg of fluoride per 50 ml, and less than 2% for concns. of 25–50 µg. Optimum concn. of color reagent and effect of pH value and interfering ions are discussed. Color reagent is stable for at least 1 month.—WPA

**Effect of pH on High-Salt-Thorium Fluoride Titration.** D. F. ADAMS & R. K. KOPFF. Anal. Chem., 28:116 ('56). Investigation into effect of pH value of final titration soln. on microdetn. of fluoride by salt-acid-thorium method is described. It was shown that apparent concn. of fluorine was inversely related to pH value of final titration. Modified procedure giving greater reproducibility is described, in which titration is conducted at pH value of 2.9 instead of 2.7 and correction is made for effect of pH value.—WPA

**The Determination of Microgram Quantities of Fluoride.** V. The Use of the Aluminium-Chromeazurol-S. Complex. B. J. MACNULTY & L. D. WOOLLARD. Anal. Chim. Acta, 14:452 ('56). Spectrophotometric method for detg. fluoride, using aluminium-chromeazurol-S complex, is described. Fluoride in soln., free from interfering ions, or obtained by distn. as hydrofluosilicic acid, is detd. by destruction of complex, amt. destroyed being directly proportional to concn. of fluoride. Method can

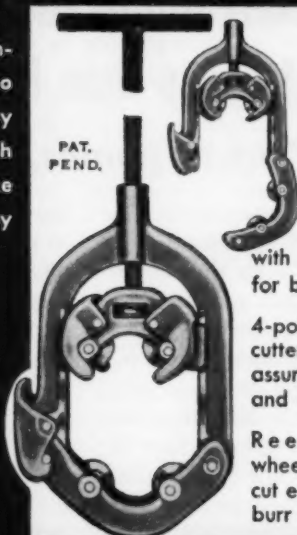
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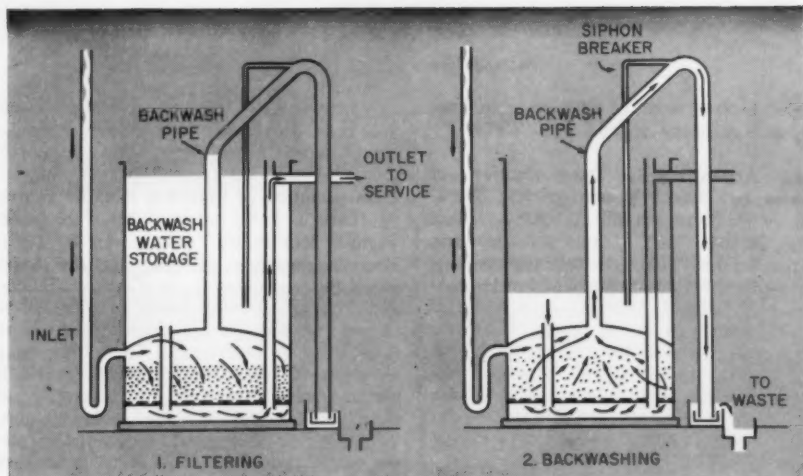
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(Continued from page 80 P&amp;R)

be used to det. concn. of 0.02–20  $\mu\text{g}$  of fluoride, with accuracy of  $\pm 0.6 \mu\text{g}$ .—WPA

**Rapid Argentimetric Determination of Halides by Direct Potentiometric Titration.** V. J. SHINER & M. L. SMITH. *Anal. Chem.*, **28**:1043 ('56). Direct potentiometric titration method with silver nitrate has been developed for quant. detn. of chloride, bromide, and iodide in soln. of acetate buffer containing few drops of liquid, non-ionic detergent. Error is less than 0.1% for concns. as low as 0.002M, and less than 1% at limiting concn. of  $10^{-4}$ ,  $10^{-5}$ , and  $10^{-6}$ M for chloride, bromide, and iodide respectively. Method is rapid, and can be used for direct detn. of mixed halides.—WPA

**New Process for Determination of Small Amounts of Hydrogen Cyanide in Water and Waste Water.** G. GAD & H. SCHLICHTING. *Gesundh. Ing. (Ger.)*, **76**:373 ('55). Authors carried out comparative expts. with Liebig and Volhard volumetric methods and colorimetric method of detn. of cyanide. Results, which are given in a table, showed great differences between volumetric and colorimetric methods. These are ascribed to loss of cyanide during warming necessary to complete conversion of cyanide to thiocyanate. Both volumetric methods gave satisfactory results when concn. of cyanide was greater than about 1 mg; for concn. down to about 0.5 mg Liebig method was more sensitive. Efforts were then made to increase sensitivity of Liebig method, which is limited by the soly. of silver chloride, by using greater amt. of water, by limiting amt. of distillate, and by concg. distillate. Finally new method was developed, based on observation that, in detn. of silver with Feigl reagent, red silver compd. did not form in presence of cyanide ion. If drops of silver nitrate soln. are added to weakly alkaline solution of cyanide, positive silver ion first combines with cyanide ion to form negative complex silver cyanide ion. When all cyanide is used, excess silver ions form red silver salt with reagent. Color reaction is sensitive and endpoint of titration is clear and much more easily seen than turbidity which shows endpoint in Liebig method. Results, compared in table with those of other methods, show that new method is 10 times more sensitive than other volumetric methods and considerably more accurate and reliable than

colorimetric detn. Details of reagents and procedure for simple and complex cyanides are given.—WPA

**Determination of Iodine in Potable Water.** A. HAIM & J. F. SAREDO. *An. Fac. Quim. Farm., Montevideo (Ur.)*, **4**:155 ('55). Procedure for detn. of iodine in water, based on method of Bratton, McClendon, Foster, and White, in which iodine is oxidized to iodate with bromine water and titrated with thiosulfate, is described. Factors affecting sensitivity of method were investigated. If starch is used as indicator, at least 0.4 g of iodine is required to effect color change. Up to 3% of iodine is not oxidized by treatment with bromine, up to 1.7% fails to distil over into bromine water, and as much as 8% may be lost during preliminary calcination of sample.—WPA

**Determination of Total Nitrogen in Waste Waters From Sugar Factories.** E. ZYMNÝ & Z. ZUCKERIND. (*Czech.*), **5**:81 ('55). For detn. of total nitrogen in presence of nitrate and nitrite nitrogen, author recommends, in place of method given in German Standard Methods, a method described by Authenrieth and Taege in 1922. This method, omitting distn. and using Hellige Universal Colorimeter, gives satisfactory results. 100 ml of waste waters with 5 ml of concd. sulfuric acid, 5 g of potassium sulfate, and about 0.5 g of selenium reaction mixture, are heated in long-necked Kjeldahl flask for about 1 hr with vigorous boiling. After cooling, contents of flask are rinsed.—WPA

**Practical Use of Electrochemical Method of Determination of Oxygen in Water. I. Principles; Long-Term Measurements.** H. AMBÜHL. *Schweiz. Z. Hydrol. (Switz.)*, **17**:123 ('55). Author discusses basic principles of electrochemical detn. of oxygen and problems which arise in practical application of method. Expts. made to reduce influence of flow of water on oxygen diffusion current showed that lattice-like cathodes of gold gave best results; such gold screens could be constructed as microcathodes. Influence of variations in cond. on diffusion current cannot be completely eliminated; cond. current curves run parallel to axis only at high contents of salt; influence can, however, be considerably reduced by reducing size of cathode. Lime incrustations, which in water

(Continued on page 86 P&amp;R)

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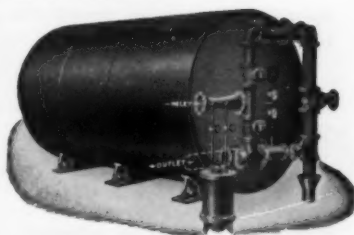
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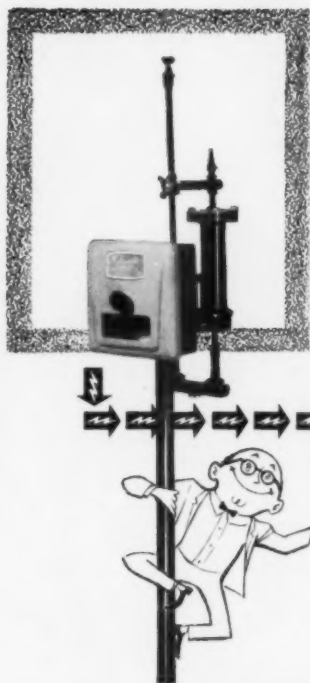
(Continued from page 84 P&R)

containing bicarbonate render measurement difficult or impossible, cannot be eliminated by use of Tödt's gold amalgam electrode. Long-term expts. with water contg. and free from carbonate, showed that cathodes of gold plate, gold screen, gold amalgam screen, and mercury gave inconstant values, the current decreasing with increasing time; use of zinc anode behind diaphragm did not give much improvement. Mercury cathode, cleaned automatically at intervals of few minutes by motor-driven rubber spatula, gave an almost constant current, and small residual decrease could be completely eliminated by using zinc anode behind diaphragm. It is thus possible to record over any required period oxygen content of water with constant cond., temp., and rate of flow. Self-cleaning mercury electrode is being developed for general use in lab. and water works practice. Improved oxygen plummet for short-term measurements in field is in preparation.—WPA

**A New Method for the Colorimetric Determination of Oxygen Dissolved in Water.** M. TANAKA. *Mikrochim. Acta* (Aust.), pp. 1048 ('55). Colorimetric method has been devised for detn. of D.O., using decolorized soln. of manganese-formal-doxime. Preparation of manganic derivative of formaldoxime and its reduction by zinc powder are described, and procedure and app. for detn., are described and illustrated. Orange-red color, which develops within 5 min and is stable for over an hour, can be measured spectrophotometrically at wavelength of 475m  $\mu$ , or by comparison with color standards. Ferric iron interferes, but no interference is caused by nitrate, nitrite, ferrous iron, or organic matter.—PHEA

**Determination of High-boiling Paraffin Hydrocarbons in Polluted Water.** F. J. LUDZACK & C. E. WHITFIELD. *Anal. Chem.*, 28:157 ('56). In studies of poln. of water by oil, difficulties have often been experienced in anal. methods used, resulting in incomplete recovery of oily materials, lack of identification of major components, or inadequate removal of interfering substances. Method has now been devised by which it is possible to det. amt. type, and condition of oily residues in presence of mixed components in pold. water. Method involves continuous liquid-liquid extraction with air agitation, infrared anal. for quant. detn. of

(Continued on page 88 P&R)



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(Continued from page 86 P&amp;R)

oil concn., and chromatographic sepn. to isolate mineral oils from animal or vegetable oils, soaps, and miscellaneous extractable components.—WPA

**Determination of Steam-Volatile Phenols in Water From Distillation of Brown Coal.** H. ANDERS. No. 6, 194-196; Literaturber. Wasser, Abwasser Luft u. Boden, 4: 236 ('55). Various methods for detn. of phenol are described. In examining waste water from distn. of coal by Koppenschaar method, preliminary treatment of sample is necessary because of presence of interfering substances. Large amts. of hydrogen sulfide are driven off by acidifying sample with acetic acid and boiling in reflux condenser. 5 ml of sample are treated with excess of ammoniacal copper sulfate soln. and then with 5-8 ml of 40% potash lye, and are boiled in sloping distn. flask until no more ammonia is detectable. Distd. water is added, sample is neutralized with carbon dioxide, and finally volatile phenol is driven off in current of carbon dioxide. Distn. must be repeated 3 times, if necessary with addition of distd. water. Detn. is carried out iodometrically. Unused bromine can also be determined with arsenious acid by back-titration with 0.1 N bromide-bromate soln. without use of iodine. For detn. of small amts. of phenol nitraniline process is recommended, and for detn. of total phenol a counter-current extraction process. Phenols are detd. gravimetrically and those fractions which are distd. off with solvent (Phenosolvan) must be taken into account; a process for their detn. is given.—WPA

**The Determination of Small Amounts of Sulfate by Reduction to Hydrogen Sulfide and Titration with Mercuric or Cadmium Salts with Dithizone as Indicator.** E. E. ARCHER. Analyst (Br.), 81:181 ('56). Procedure is described for detn. of sulfate. Sulfate is reduced to hydrogen sulfide by heating at 100°C with mixture of hydriodic and hypophosphorous acids, hydrogen sulfide evolved carried over in stream of nitrogen and absorbed in dilute alkali-acetone mixture to which little dithizone has been added. On titration with mercuric acetate, insol. sulfides are pptd., but at endpoint bright red dithizonate is formed. Cadmium sulfate can be used as titrant instead of mercuric acetate, but gives less accurate results when very small amts. of sulfur are present, possibly as result of slight soly. of cadmium sulfide.—WPA

**The Use of Ion Exchange in Hydrochemical Analysis. II.** M. V. TOVBIN & F. G. DYATLOVITSKAYA. J. Chim. Ukr. (U.S.-S.R.), 20:434 ('54). It is thought that anion-exchange resins are not suitable for anal. of natural waters as their use requires considerable time and large amts. of reagents. In method for detn. of chloride in presence of sulfate, excess barium hydroxide is added to sample and ppt. of barium sulfate is filtered off. Excess barium hydroxide is neutralized by passage through cation-exchange resin, and amt. of acid formed is equiv. to concn. of chloride in water.—WPA

**The Physico-Chemical Analysis of Water.** G. NOISSETTE. L'Eau (Fr.), 43:169 ('56). It has been shown that in event of deep drilling, when water of abnormal mineralization is found in course of flow tests, compn. of water in respect to its alkaline content is function of time of storage at those depths. This is shown by means of graphic charts using a cationic water. Development of such graphs permits estn. or anticipation of true compn. of acceptable potable water, and consequently value of drilling through which it was found.—PHEA

**Application of Versenes to the Analysis of Water.** E. M. LENA. An. Fac. Quim. Farm., Montevideo (Ur.), 4:181 ('55). Magnesium and calcium in local waters round Montevideo were detd. by titration with Versene, using Eriochrome black T as indicator. Optimum pH value was found to be 10. If pH value is acidic, magnesium-Versene complex is unstable and endpoint is not clear, while pH values above 10 magnesium hydroxide is pptd. Results obtained by this method compared favorably with those obtained by soap methods.—WPA

## DAMS AND RESERVOIRS

**Twelve Years of Chemical and Biological Investigations on the Pleisse Dam.** B. MEISSNER. Wasserr.-Wass. Techn., 4:326 ('54). Since filling in 1941 of Pleisse dam, which supplies water for 2 large brown-coal works, chemical, physical and biological observations have been made almost daily. During 12 yrs, condition of water has deteriorated, as result of increase in amt. of domestic and industrial waste water carried into it by Pleisse. Self-purification is no

(Continued on page 92 P&amp;R)

75

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to serve you**

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## **Water Wells Vertical Turbine Pumps Water Treatment**



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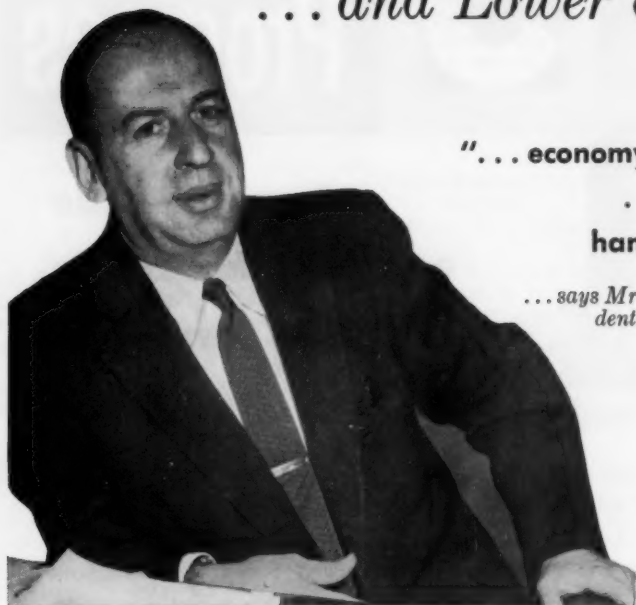
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... far superior  
handling dry alum

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ization of your present dry Alum operation. In either case, Cyanamid can contribute valuable know-how on the design and installation of Liquid Alum systems... as well as valuable information gained from previous experience in dry-to-liquid Alum conversions.

Why not call in your Cyanamid representative and let him determine approximately what your savings will be? Apart from economies which will quickly pay off installation costs, you can count on a greater operating flexibility with the same manpower.



Automatic orifice metering of liquid alum reduces supervisory requirements — assures accurate control.

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(Continued from page 88 P&amp;R)

longer sufficient and deposition of sludge has encouraged plant growth which in turn increases sludge deposits. Conc'n. and deg. of saturation with oxygen have decreased, aggressive carbon dioxide has been formed, and conc'n. of hydrogen sulfide in sludge has increased from few mg per kg to about 900 mg per kg. Organisms present, which were originally of oligo- and  $\beta$ -mesosaprobic types, are now mainly  $\alpha$ -mesosaprobic and polysaprobic. Sludge deposits have increased to thickness of 20 cm and decomposition of sludge causes secondary pollution of supernatant water. Lack of oxygen, presence of aggressive carbon dioxide, and strong plankton development have led to difficulties in water supplies and use of water from dam may have to cease in not-too-distant future.—WPA

**Construction of a Covered Service Reservoir in Colloidal Group Concrete.** H. SEDDON. *J. Inst. Water Engrs.*, 10:20 ('56). Colloidal grout has a very useful application in design of water-retaining structures. Colloidal grout concrete construction is eminently suitable where only small labor force is available, and it is not desired to spend large capital sums on plant. Colloidal grout concrete can be used very effectively in construction of reinforced-concrete beams and roofs. Large areas of reinforced colloidal-grout concrete can be laid without expansion or contraction joints, without any apparent cracking. Although reasonably cheap reservoir has been obtained by method of construction described in paper, it is apparent that considerable economies may be obtained by varying design in certain details, depending on site chosen, although still adhering to basic principles.—PHEA

**Weir Wood Reservoir and Treatment Works Ensuring a Water Supply for Crawley New Towns Growing Demands.** ANON. *The Surveyor*, 114:955 ('55). Res. capac. is 1,240 mil gal. Earth dam is 41 ft high and tapers from 15 ft to 300 ft in width. Its core is local puddle clay. 90-ft deep cut-off trench is grouted with concrete. Dam has settled 3 in. There are two levels for drawoff. Flood water is carried off in a 10-ft diam. tunnel. Water enters treatment plant through venturi meter that measures flow and proportions alum and chlorine flash mixed. Flocculation takes place in 12 upward-flow, sludge blanketed sedimentation

tanks. There are 5 rapid gravity filters that normally operate at 80 gal/sq ft/hr but can be worked at 25% overload. Cleaning is by compressed air process. Chlorine is applied at clear-water tank inlet. Pumping plant is vertical spindle borehole type. 2 new concrete distributing res. having capacs. of 1 and 4 mil gal have been built.—PHEA

**The Usk Reservoir Scheme of the Swansea Corporation.** Water & Water Eng., 59:377 ('55). Details are given of constr. of dam and headworks of Usk res. to impound up to 2,700 mil gal as addnl. supply of water for Swansea, S. Wales. Compensation water to be returned to river avgs. 1.9 mgd. Of total catchment area of 3,880 acres, avg. annual rainfall of which is 66 in., 2,040 acres are owned by Swansea Corporation Water Undertaking; approx.  $\frac{1}{3}$  of Corporation's land is leased to Forestry Commission, planting of trees being advantageous in reducing flood discharge and in increasing runoff in dry weather. From stilling basin at downstream end of dam water is carried in a 28-in. main to treatment works at Bryn Gwyn; treatment consists of flash mixing with aluminium sulfate as coagulant, flocculation and sedimentation, filtration through 8 rapid gravity filters, and chlorination. Water from filtered-water storage tank of 0.5 mil gal capac. is delivered a further 9 mi. to a break-pressure tank at Craig Fawr, and thence to 2 newly-constructed service res., each of 2.5 mil gal capac. at Swansea.—WPA

**Biology of the Eye Brook Reservoir—II: The Second Seven Years.** G. C. S. OLIVER. *J. Inst. Water Engrs.*, 9:611 ('55). This paper is sequel to one published by author in 1948, which described biology of res. of Corby (Northants.) and District Water Company—Eye Brook Res., during first 7 yrs. of its existence. Now after second 7 yrs. of observation of its biology, res. would appear to have settled down, especially as regards algae. Composition of plankton over period is analyzed, and results of copper sulfate dosing, which was found to be necessary on 2 occasions, are given. Fish pop., and its various infections is considered, while birds seen within res. boundary are listed in appendix. In addn., land vegetation occurring while level of water drops sufficiently to expose bottom mud, is mentioned.—PHEA



City of New York, 66" diameter steel water pipe line, lined and coated, installed approximately 50 years ago. Still in service.

## STEEL PIPE the "Water Boy" that never shows its age

Of all the water carriers, strong, durable steel pipe is the one pipe that assures you the most dependable, trouble-free service for the longest time. City after city is still getting top performance from steel pipe lines that are 50, 60, 70 years old . . . or even older.

That's one reason why those same cities again choose reliable steel pipe when they extend their water mains. They know, too, that the great improvements in steel and pipe fabrication, plus the added protection of scientifically-applied linings, coatings and wrappings, guarantee an even longer, more useful life for their new pipe lines.

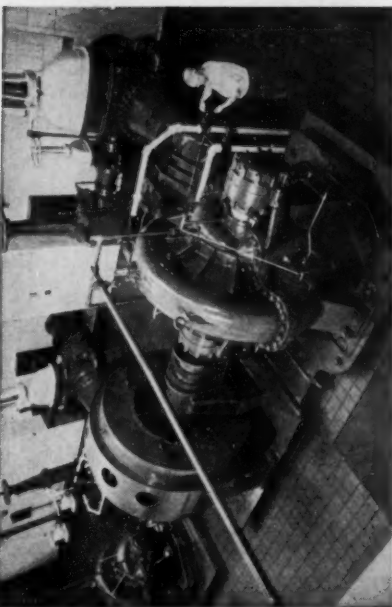
So if you, too, want a pipeline that will stand up under generations of hard usage without showing its age, you're smart to specify STEEL pipe.

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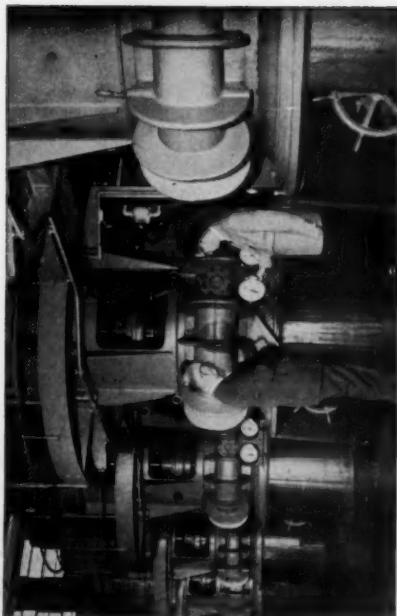
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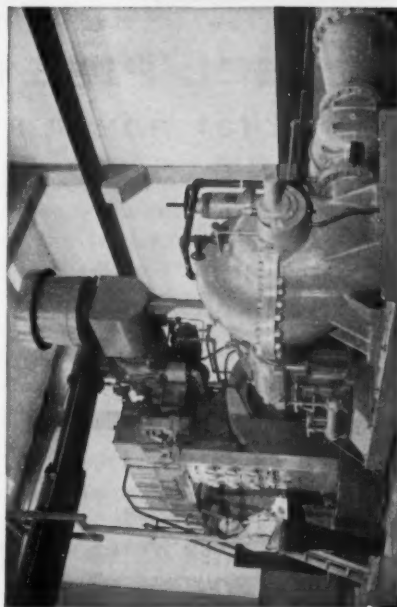




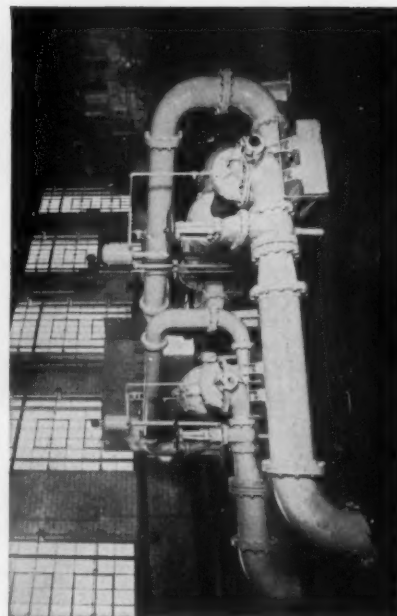
**PHILADELPHIA, PA.** One of ten Worthington high lift centrifugal pumps at the Torresdale Pumping Station. Capacity of this pump is 40 MGD.



**NIAGARA FALLS, N. Y.** Worthington high lift pumps in the Water Filtration Plant. In all, there are ten Worthington pumps, 15 to 30 MGD each.



**MIAMI, FLA.** One of four Worthington 15 MGD pumps



**SHARON, PA.** Two Worthington two-stage centrifugal

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**You benefit 3 ways when you deal with Worthington—  
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**High output and low costs.** Literally thousands of municipalities from the smallest to the largest have found that they get high volume output and low operating costs when they install water works equipment by Worthington. Every day, the reliability of this equipment is thoroughly proved in installations like those pictured here.

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W.6.6

# WORTHINGTON



ALL MAJOR PUBLIC WORKS EQUIPMENT UNDER ONE RESPONSIBILITY

(Continued from page 52 P&amp;R)



concentrating on these two projects. That it will be more than more than full we are certain, too. And in congratulating him on another job well done, we look forward to many happy returns of the day.

**The brass ring** in the above photograph circles the 500th member of the Indiana Section and the first governor on the rolls of AWWA. Smiling above the bow tie in the center is Governor Harold W. Handley of the Hoosier State, surrounded by the brass of the Indiana Section, including (left to right): Robert W. Heider, acting director, Div. of Sanitary Engineering, Indiana Board of Health; Howard S. Morse, board chairman, Indianapolis Water Co., twice national director and former Section chairman; Jack Gordon, consultant, South Bend, Section membership committee; Ray Rinehart, James B. Clow & Sons, South Bend,

present Section chairman; Clyde E. Williams, consultant, South Bend, national director for the Section; Garland G. Skelton, Public Service Commission member who sponsored Governor Handley's membership; and Lewis S. Finch, vice-president and chief engineer, Indianapolis Water Co., and AWWA's new veep. Through his membership, the governor hopes, he said, "to be in constant touch with the problems confronting the water utilities of the state, as well as the overall situation regarding both surface and ground water supplies."

To the Indiana Section, we can say congratulations not only for a 500th member, but for an alert and dramatic step to point up the importance of water supply problems, as well as to gain support for the water works field. To the Michigan Section in its membership competition with Indiana, hmmm. And to the other 46 states . . .

(Continued on page 98 P&amp;R)



# ferri-floc

FERRIC SULFATE

## The Superior **COAGULANT** With The Plus **FACTORS—**



Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

### WATER TREATMENT

Efficient coagulation of surface or well water. Effective in lime soda-ash softening. Adaptable to treatment of all industrial applications.

LIQUID  
SULFUR DIOXIDE  
HIGHEST  
QUALITY  
**SO<sub>2</sub>**

SULFUR DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

### SEWAGE TREATMENT

Ferri-Floc coagulates wastes over wide pH ranges — It provides efficient operation regardless of rapid variations of raw sewage — Is effective for conditioning sludge prior to vacuum filtration or drying on sand beds.



### COPPER SULFATE

COPPER SULFATE will control about 90% of the microorganisms normally encountered in water treatment more economically than any other chemical.

- Excellent taste and odor control
- Increased filter runs
- Coagulation over wide pH ranges
- Rapid floc formation ● Economy
- Turbidity removal ● Color removal
- Manganese and Silical removal
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**1940-1955**

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These features make the new 16-year Cumulative Index (clothbound, 192 pp.) a time-saving, easy-to-use guide to JOURNAL AWWA for 1940-1955:

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**List price, \$4.50**

**Price to members sending cash with order, \$3.60.**

**AMERICAN WATER  
WORKS ASSOCIATION**

**2 Park Ave., New York 16, N. Y.**

*(Continued from page 96 P&R)*

A substitute for water has at long last been announced, the revelation coming from Dr. J. M. Sharf, research scientist of Lancaster, Pa. Of course, the Sharf substitution is intended only as a stopgap during atomic attack and then only for drinking, but we, who have had some first-hand experience along that line, can concede the genius of the idea. The formula varies, but in all variations is extremely potable; it is generally available and easy to store; and it is almost certain to make the shelter a happier place to be. The idea, of course, is beer—canned beer—and we're stocking our cellar right now.

Meanwhile, as one slightly harder to please, Nelson Eidson, a plumber at Dallas, N.C., recently designed and installed his own system for protecting his plumbing against a dryup in the event of a main break through enemy or, for that matter, any action. Unfortunately Eidson didn't wait for an emergency to cut in his auxiliary supply, and a revenue officer happened to turn on the kitchen tap during one of the frequent drills. Being an old hand, the officer didn't take long to trace the copper tubing to a 42-gal tank in the backyard with the proof—as a matter of fact, 100 proof—that the source was illegal.

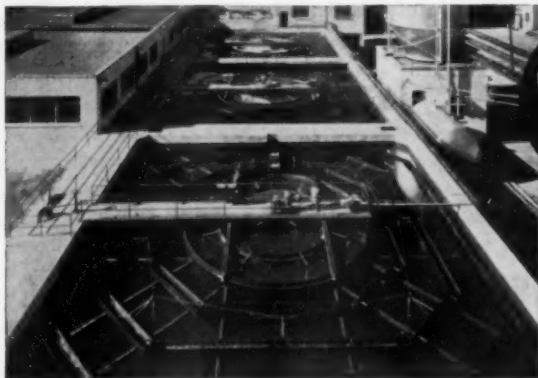
Eidson is free now on \$500 bond—the price of being ingenious rather than just plain genius. As a matter of fact, having seen what the atom bomb can do and translating that into the destructiveness of an H-bomb, we aren't so sure that the Eidson whisky system isn't 33 per cent, or 66 proof, better than the Sharf beer plan. As the expression goes: "When rape is inevitable . . . ."

*(Continued on page 100 P&R)*

WALKER PROCESS

# Clariflow

Orlando, Florida Water Treatment Plant includes three Walker Process Clariflows for lime softening as well as algae and color removal. The unit in the foreground, completed in 1954, increases the plant capacity to 24 MGD. The two original Clariflows were installed in 1949. Each unit is 56' square x 17' deep.

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FLORIDA**

Consulting Engineers—  
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Utilities Commission —  
Mr. C. H. Stanton, Mgr.  
Orlando Water Dept.—  
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The Clariflow combines flocculation, good fluid mechanics and clarification in a relatively small tank. Mixing, flocculation, stilling and sedimentation are independently operated and controlled. The positive control of flocculation and clarification enables the operator to readily select the most economical method of operation when handling changeable water conditions.

Short circuiting tendencies are eliminated by means of exclusive multiple, tangential diffusers which simultaneously and equally distribute the flow. Balanced multiple surface weir troughs make efficient use of short detention periods and insure clarified overflows.

The Clariflow is applicable wherever there is a municipal or industrial need for water or waste treatment. It can be used in all operations including combined intimate chemical homogenizing, flocculation and clarification in rectangular, square or circular basins. The Clariflow gives excellent results in the treatment of municipal and industrial water for—softening—turbidity removal—color removal—algae removal. Industrially it is universally used in—oil separation and emulsion breaking plants—blast furnace flue dust thickening—paper stock reclamation.

Write for bulletin 6W46.

**WALKER PROCESS EQUIPMENT INC.**  
FACTORY—ENGINEERING OFFICES—LABORATORY  
AURORA, ILLINOIS

(Continued from page 98 P&R)

**Garvin H. Dyer**, manager and chief engineer, Independence Div., Missouri Water Co., takes over Jul. 1 as president of the National Society of Professional Engineers.


**General Waterworks Corp.** has acquired the Wakefield Water Co. in Rhode Island and the Carolina Water Co. in North Carolina. The corporation now serves more than 200 communities in nineteen states.

**Face** has always been a matter of first importance in Japan, and apparently it still is. Thus, when the dog-bitten postmen of Toyooka decided that they had had enough of canines' canines, they put their letter of complaint to dog owners in these terms: "Please keep your beloved dogs leashed


during the daytime so that we may be able to maintain dignity and rights as humans." In the US, the letter would probably have been a little less polite and, undoubtedly, a lot more materialistic in its reasons. But then, as meter readers are well aware, it isn't face that has to be saved when US dogs attack.

**H. R. Godfrey** has been named manager of product sales for Allis-Chalmers' West Allis centrifugal pump department. He was formerly assistant to the general manager of the firm's General Products Div.

**Lester E. Jordan** has been appointed district engineer in charge of the Philadelphia office of Portland Cement Assn. He has been with the organization since 1947.

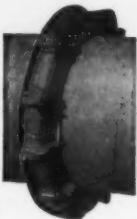


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C-I-60 CAST  
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Carson glands and bolts made of corrosion-resistant C-I-60 cast iron—last as long as cast iron pipe. Glands accommodate variations in pipe dimensions, insure uniform compression of rubber gasket.

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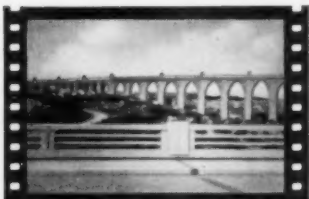
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ON WATER SUPPLY SYSTEMS



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**PRESSURE**  
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WATER FOR GENERATIONS TO COME



## Correspondence

### Me-ow-ter

To the Editor:

Re your cat's meow story (March 1957 P&R, p. 78):



ROY RUGGLES

Atlanta, Ga.  
Feb. 18, 1957

### Tin Can Ally

To the Editor:

Gold mining has been carried on in the Siskiyou Mountain region of southern Oregon since the precious metal was discovered there in 1849. Thousands of white men and Chinese have extracted millions of dollars in gold from the gravel of the stream beds and veins of ore in the surrounding mountains.

As a lad in my early teens, I spent several summer vacations with my parents at a placer mining camp on Sucker Creek, a tributary of the Rogue River. All supplies, including condensed milk in tin cans, were brought into the mines by pack horses and mules over trails. One of my jobs at the mine was turning the grindstone in the shop where tools were sharpened, and it was a very tiresome and boring job for a young fellow who

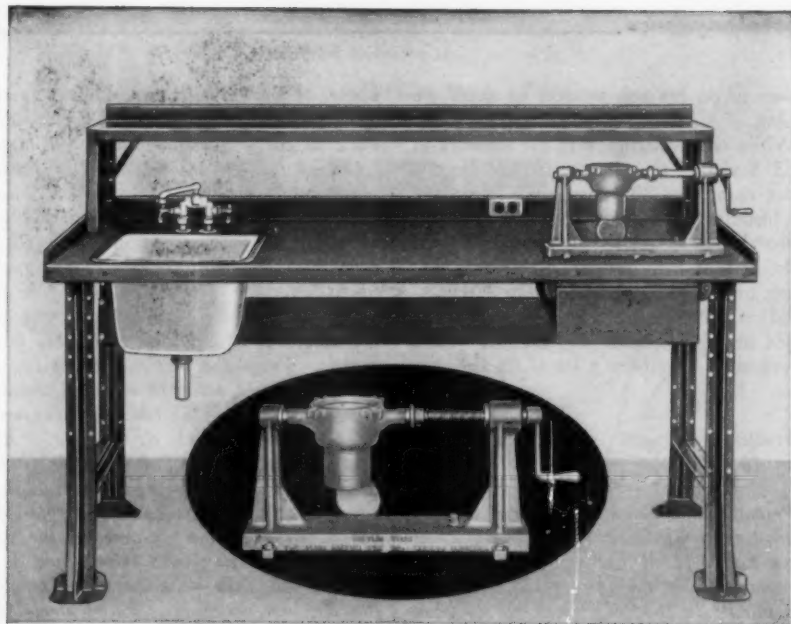
was more interested in fishing and hunting.

One day during the summer of 1911, the idea came to me that the empty tin milk cans could be made into a pipeline for a water wheel power plant that could turn the grindstone. So I proceeded to take the tops and bottoms off the cans by heating them in the forge to melt the solder, and then to swell one end of each can by placing the tin cylinders over the anvil horn and hammering the edge so that the cans would fit together like sections of stovepipe [see photo below]. The pipeline was then laid up the hill behind the shop to a ditch carrying water to the mine workings. The ditch was about 20 ft higher than the shop.



A water wheel was made by placing cone-shaped cups, made of tin, on the edge of a 14-in. wooden disk which was mounted in the shop. A belt and pulleys connected the water wheel to the grindstone, and, when water was turned into the pipeline, the little power plant worked beautifully. A lad's ingenuity and a pile of empty milk cans had harnessed water

(Continued on page 104 P&R)



## METER REPAIR BENCH . . .

*Complete with Vise and Sink*

Send for  
Ford Catalog  
No. 56.

Here is a repair bench designed specifically for the water meter shop. A 34" x 72" working top supports a 15" acid resisting sink, a meter vise that holds meters from  $\frac{5}{8}$ " to 1" in size and a tool drawer. Above the bench is a shelf. Bench may be equipped with pressed wood top, two drawers or two shelves if desired. Electrical and air hose connections are standard equipment. Complete information gladly supplied.

**FORD**

FOR BETTER WATER SERVICES

THE FORD METER BOX COMPANY, INC. Wabash, Indiana

## Correspondence

(Continued from page 102 P&amp;R)

power to do his job so that he could go fishing.

While on a vacation trip the summer of 1953, I visited the site, which has been a ghost camp for 30 years, and found the log buildings crumpled and sagging. As I prowled around the old shop, I caught sight of that little old tin pipeline almost intact and in a remarkable state of preservation, considering that it had been exposed to the elements for over 40 years. There must have been a lot of tin in those cans.

FRED OSBORN

Corvallis, Ore.  
Mar. 10, 1957

Friend Osborn's story of the heroics of tin-tin-tin might normally have elicited some doggerel at the very least. Unfortunately (?), the doggerel is now dead and buried in the interstices of our own

home, together with the radiant-heating system that drowned it. There were days back in early February when we almost followed it as, with hammer and chisel, we spent every free hour chopping holes through a 3-in. concrete floor to discover why our meter was meowing with all the taps shut off. The answer, of course, was the failure of the 1-in. steel pipe that had been laid in sand between the two 3-in. slabs of concrete on which the house stands. From the fact that the pipe wall had been eaten away to eggshell thinness from the outside, the cause was assumed to be stray-current electrolysis. And, when some 12 ft of floorbreaking had failed to reveal any pipe solid enough to repair, the cure was solid concrete—and baseboard radiation. Some of the wizardry of Osborn would have stood us in good stead then—condensed milk cans, that is, instead of evaporated steel.—ED.

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Classified ads will be accepted only for "Positions Available" or "Positions Wanted." Rate: \$1.50 per line (minimum \$5.00), payable before publication. Deadline for ad copy: first of month prior to month of publication desired. To place ad, obtain "Classified Ad Authorization Form" from: Classified Ad Dept., Journal American Water Works Assn., 2 Park Ave., New York 16, N.Y.

### Positions Available

**Manager, Water Div., Public Utility Agency of Guam.** Will have administrative, technical, and supervisory responsibilities. Salary \$8,580-\$10,725, plus two-way transportation for employee and family; furnished housing provided at reasonable rental. Two-year contract subject to renewal by mutual agreement. Write: Peter C. Siguenza, Director, Dept. of Labor & Personnel, Government of Guam, Agaña, Guam.

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**City after City  
Town after Town**

*Swinging to*

# CALMET

**"IT MEASURES  
EVERY DROP"**



MANUFACTURED BY  
**WELL MACHINERY  
& SUPPLY CO., INC.**  
FORT WORTH, TEXAS



## Section Meetings

**Illinois Section:** The 47th annual meeting, Mar. 20-22, at the LaSalle Hotel, Chicago, was the largest ever held by the Illinois Section. A total of 474 were in attendance throughout the 3 days. At the business luncheon, the following officers were elected for the ensuing year: C. L. Baylor, chairman; T. E. Larson, vice-chairman; J. C. Vaughn, junior trustee; and H. H. Gerstein, director. The reports of the various committees were read and placed on file.

At the banquet, the annual nominee for the Fuller Award was announced—Horace R. Frye, superintendent of the Evanston Water Dept. Life Membership certificates were awarded to Max Fishstein and Ralph Noble. This year the Section, for the first time, gave a special award to one of its outstanding members, M. H. Foley, in appreciation of his service and leadership on many entertainment committees over an extended period of years, for both the Section and the Association.

Many excellent papers of both a scientific and a practical character were presented, with emphasis on the latter. These covered all phases of water works operation. [A list will appear in the December 1957 JOURNAL.] Three movies on water construction projects were shown. The first covered the Gary, Ind., Filtration Plant; the second, the installation of Bascule Gates on the dam at Decatur, Ill.; and the third, the erection of large elevated storage tanks.

D. W. JOHNSON  
*Secretary-Treasurer*

**Southeastern Section:** Meeting at the Francis Marion Hotel, Charleston, S.C.,

Mar. 17-19, 1957, the 28th annual session of the Southeastern Section was attended by 335 registered members and guests, a record high for the Section. This increase was due in part to the unusually large number of wives who accompanied their husbands to the meeting and enjoyed the gracious entertainment provided by the Hostess Committee under the able guidance of Mrs. John R. Bettis, wife of Charleston's water department superintendent.

One of the features of this meeting was a luncheon on Monday, Mar. 18, honoring the retired members of the Section and their wives. On hand for this occasion were seven retired superintendents or engineers from the Section, including Mr. and Mrs. John F. Pearson, Orangeburg, S.C.; Mr. and Mrs. Francis B. McDowell, Charleston, S.C.; Mr. and Mrs. Frank W. Chapman, Greenwood, S.C.; B. B. Meng Sr., Winnsboro, S.C.; Homer Schumpert, Newberry, S.C.; Guy H. White, Columbia, S.C.; and B. P. Rice, Atlanta, Ga. Also present were Mr. and Mrs. T. M. Starnes of the Alabama-Mississippi Section and C. L. Korner of the North Carolina Section, both retired.

Speaking at this luncheon, E. L. Filby, engineer, Black & Veatch, Kansas City, Mo. (formerly state sanitary engineer in South Carolina), related numerous amusing, interesting, and informative incidents connected with the water works profession in South Carolina in the World War I period.

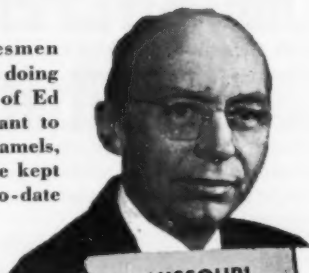
The technical part of the meeting opened Monday morning, when Mayor Pro-Tem C. O. Thompson welcomed the group to Charleston. He was followed by AWWA President Paul Weir and by

(Continued on page 108 P&R)

WHEN IT COMES TO SERVICE

# COME TO REILLY

- Each of the Reilly salesmen knows what the others are doing thanks to the hard work of Ed Goodman. This is important to the buyers of Coal Tar Enamels, for in this way they can be kept advised of the most up-to-date experience of others.



- Ernie Rouland enjoys the goodwill of Reilly customers because he carries out the Company's mission of supplying high quality products and comprehensive service. For Reilly Coal Tar Enamel, Ernie will be proud to have you call him.



**Reilly Tar & Chemical Corporation**

MERCHANTS BANK BUILDING, INDIANAPOLIS 4, INDIANA

*Sales Offices in Principal Cities*

P.O. Box 370, Granite City, Illinois

**Section Meetings**

(Continued from page 106 P&amp;R)

Chairman Carl C. Lanford, who spoke about some of the needs of the Section. [A list of the technical papers presented will appear in the December 1957 JOURNAL.]

At the business meeting Tuesday morning, the following officers were elected to serve for the coming year: chairman—Robert C. Kauffman, Atlanta, Ga.; vice-chairman—John R. Bettis, Charleston, S.C.; and trustee—Oscar M. Fuller, Union, S.C. Sherman Russell, national director, and L. R. Simonton, trustee, continue in office for another year. N. M. deJarnette was reappointed secretary-treasurer.

The Annual Banquet was held Tuesday evening. The Fuller Award Committee announced W. T. Linton, state sanitary engineer, South Carolina Board of

Health, as the Section's choice for the award.

Additional activities at this meeting included a "Meet and Greet" party Sunday evening; cocktail parties and other entertainment provided by the manufacturers' representatives and WSWMA, ably planned by Denzle Q. Whitehair and his Club Room Committee; a boat trip around the Charleston harbor as guests of the US Navy's Mine Craft Base, commanded by Admiral Neil K. Dietrich; and, for the ladies, a boat trip up the Ashley River to the Magnolia Gardens, a bus tour of the city and its scenic and historical spots, and a luncheon at the Country Club as guests of the Charleston Water Dept.

N. M. DEJARNETTE  
*Secretary-Treasurer*

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During 1956 we built a large number of durable and efficient low cost water treating plants for the removal of iron, manganese, hardness and other undesirable impurities. These plants operate *automatically*, require very little space and are unusually inexpensive to operate and maintain.

*Full Particulars on Request*

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SERVICE**

# HUNGERFORD & TERRY, INC.

CLAYTON 5, NEW JERSEY



## "Air Flow" design prevents cavitation in Butterfly Valve

96" valve for penstock intake  
at Pleasant Valley Hydro-Electric  
Power Plant, Los Angeles, Calif.  
ENGINEERS: Los Angeles Depart-  
ment of Water and Power.

Throttling water at a high rate of flow may cause critically high velocities through the restricted area and develop a vapor pocket immediately down stream of the valve. The alternate buildup and collapse of this vapor pocket develops supernormal pressures on the face of the valve disc, accelerating erosion and causing shocks in the piping system. This phenomenon, known as cavitation, may occur regardless of the shape of the valve disc or its material of construction.

This unusual problem arose in planning the Pleasant Valley Hydro-electric Plant. Although ultimately intended for open-shut service, the 96" penstock intake valve would have to throttle flow through the waterway during the plant construction period. Pratt engineers knew from experience that cavitation would probably occur and sought to forestall damage to the valve disc and pipeline structure.

The problem was solved with a design which allows atmospheric air to pass down

the valve shaft and out through holes in the valve disc, preventing the formation of low pressure areas.

The valve and reducer are under 65 feet of water and the electric motor operator is on a floor 68 feet above the valve centerline. An oil-filled standpipe balances pressure in the reducer with outside water pressure.

This imaginative engineering is the result of 30 years experience in butterfly valve design. Specifying Pratt valves puts this experience to work for you. It helps keep installation costs down and assures years of efficient, economical operation.

**NEW! Latest, most accurate pressure drop and flow data, conversion tables, discussion of butterfly valve theory and application plus other technical information.**

Write for Manual B-2C.



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**PRATT**

RUBBER SEAT

# Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities



## NEW MEMBERS

Applications received Mar. 1-31, 1957

**Adams, Clyde B.**, Supt., Water & Sewers, Quindaro Township, 5031 Welborn Lane, Kansas City, Kan. (Jan. '57) *MD*

**Adams, Ray**, Supt., Water & Sewerage Dept., Thomaston, Ga. (Jan. '57) *P*

**Adams, Tom L.**, Office Mgr., Water Dept., 200 N. Walker, Oklahoma City, Okla. (Jan. '57) *M*

**Ames, Burton**; see Perrysburg (Ohio) Water Dept.

**Anderson, W. J.**, Village Engr., 161 Lakeshore Rd., Port Credit, Ont. (Jan. '57)

**Armentrout, Charles L.**, Sr. Designing Engr., Washington Suburban San. Com., Hyattsville, Md. (Jan. '57) *D*

**Ash, Harold**, Supt., Municipal Water Works, Chester, W. Va. (Jan. '57) *M*

**Auken, Oscar W.**, Gen. Mgr., Water & Light Utilities, Madison, N.J. (Jan. '57) *PD*

**Ault, Willard F.**; see Olympic Welding Co., Inc.

**Austin, Benjamin Reid**, Supt., Water & Light Dept., Clinton, S.C. (Jan. '57) *MRPD*

**Battley, Everett M.**, Dist. Mgr., Inflico, Inc., 325 W. 25th Pl., Chicago 16, Ill. (Jan. '57) *P*

**Bell, John H.**, Exec.-Secy., H. Bell & Assocs., Inc., 829 S. 2nd St., Chicago, Ill. (Jan. '57)

**Beno, Robert O.**, Trustee, Water Works, Pearl & Broadway, Council Bluffs, Iowa (Jan. '57) *M*

**Bhagat, Mrunal N.**, Tech. Asst. to Mng. Director, Structural Eng. Works, Ltd., Manejki Wadia Bldg., Mahatma Gandhi Rd., Bombay, India (Jan. '57) *MD*

**Bill, Howard F.**, Filtration Plant Operator, Water Works, Box 70, Keyser, W. Va. (Jan. '57) *MP*

**Blevens, Vester E.**, Supt., Water & Sewage Works, Oneida, Tenn. (Jan. '57) *MRPD*

**Bolton, Charles M.**, Supt., Water Works, City Hall, Cincinnati, Ohio (Jan. '57) *M*

**Bonsteel, Paul John**, Design Engr., Eddy Valve Co., Waterford, N.Y. (Jan. '57) *MD*

**Bothwell, Leroy Morrison**, Assoc. Engr., Clyde C. Kennedy, 604 Mission St., San Francisco, Calif. (Jan. '57) *MD*

**Bremer, Joe H.**, Salesman, Longview Lime Corp., Box 2015, Savannah, Ga. (Jan. '57)

**Brisbane, Donald Sydney**, Student, Pennsylvania State Univ., York, Pa. (Jr. M. Jan. '57) *MPD*

**Brosław, Joseph**, Exec. Vice-Pres., Ralf Shockey & Assocs., Inc., 350 5th Ave., New York, N. Y. (Jan. '57) *MRPD*

**Bulot, Francis H.**, Cons. Engr., 1323 N. Broadway, Santa Ana, Calif. (Apr. '57)

**Burd, Harold N.**, Supt., Bernards Water Co., 22 Olcott Square, Bernardsville, N.J. (Jan. '57) *M*

**Cady, Carl J.**, Asst. Gen. Mgr., Davis Mfg. Co., 321 N. Maple Dr., Beverly Hills, Calif. (Jan. '57) *PD*

**Call Public Works Dept.**, Technical Sec., Nicolas Ramos G., Gen. Mgr., Apdo. Nal 661, Cali, Colombia (Munic. Sv. Sub. Jan. '57) *MRPD*

**Caseyville Water Co.**, Earl Ohlen-dorf, Water Supt., Caseyville, Ill. (Corp. M. Jan. '57)

**Clarke, Lester J.**, San. Engr., State Dept. of Health, 3400 N. Eastern, Oklahoma City, Okla. (Jan. '57) *RPD*

**Cleator, F. J.**, Supt., Water Dist., Mukilton, Wash. (Jan. '57)

**Clore, John T., Jr.**, Plant Supt., West Helena Water Co., 519½ Poplar St., Helena, Ark. (Jan. '57) *M*

**Cohen, Stanley L.**, Partner, Sidney G. Spero & Co., 521-5th Ave., New York, N.Y. (Jan. '57) *M*

**Collier, William Henry**, Supervisor, Services & Meters, Water Works & Sewage, Suite 14, 154 Evanson St., Winnipeg 10, Man. (Jan. '57)

**Collings, Roy**, Supt. of Utilities, Johnson, Kan. (Jan. '57) *MRD*

**Cook, David M.**, Attorney, McHale, Cook, Welch & McKinney, 1006 Chamber of Commerce Bldg., Indianapolis 4, Ind. (Jan. '57)

**Cook, Donald M.**, Consultant, Middle West Service Co., 20 N. Wacker Dr., Chicago 6, Ill. (Jan. '57) *M*

**Cooke, Thomas Blacknall**, Project Engr., Dept. of San. Eng., 14th St. & Pennsylvania Ave., N.W., Washington, D.C. (Jan. '57) *RD*

**Coonrad, Robert S.**, Asst. Engr., Barker & Wheeler, 36 State St., Albany, N.Y. (Jan. '57) *RPD*

**Costello, James J.**, San. Engr. II, S. Dist. Filtration Plant, 3300 E. Cheltenham Pl., Chicago, Ill. (Jan. '57) *P*

**Courtney, Joe Davis**, Maintenance & Purification, Pan American Petroleum Corp., Box 12, High Island, Tex. (Jan. '57) *MRPD*

**Crews, Gordon M.**, Sales Repr., Neptune Meter Co., 554 E. Harbor St., Los Angeles 22, Calif. (Jan. '57) *D*

**DeLeGai, Philip**; see Forsyth, Ga.

**DeLuca, Joseph Robert**, Civ. Engr., Seelye, Stevenson, Value & Knecht, 101 Park Ave., New York, N.Y. (Jan. '57) *PD*

**Dixon Water Dept.**, O. B. Spencer, Supt., 121 E. 1st St., Dixon, Ill. (Munic. Sv. Sub. Jan. '57) *M*

**Dougherty, E. R.**, Supervisor, San. Dist., 3012 Broadway, Indianapolis, Ind. (Apr. '57)

**Doyle, M. B.**, City Civ. Engr., Box 273, Bloomington, Ind. (Jan. '57) *MRD*

**Ellis, Otto**, Supt., Water Dept., 227 E. South B, Gas City, Ind. (Jan. '57) *D*

**Elston, M. G.**, Resident Engr., Newton Eng., Ltd., Box 2290, Whitehorse, Yukon (Jan. '57)

**Evaus, Lloyd F.**, Gen. Mgr., Utilities Operating Co., Inc., 17 E. Acre Dr., Plantation, Fort Lauderdale, Fla. (Jan. '57) *M*

**Falconer, Jonathan Paul**, Civ. Engr., Chief, Tech. Liaison Branch, Corps of Engrs., U.S. Army, 112 Montgomery St., Syracuse, N.Y. (Jan. '57) *RPD*

**Fix, Robert E.**, Cons. Engr., Wisenbaker, Fir & Assocs., 1500 Peoples National Bank Bldg., Tyler, Tex. (Jan. '57)

**Foley, Charles S.**, Sales Repr., Gifford-Hill-American, Inc., 10317 Crestover Dr., Dallas 29, Tex. (Apr. '57)

**Forsyth, City of**, Philip DeLeGai, Forsyth, Ga. (Munic. Sv. Sub. Jan. '57) *PD*

**Friedrichs, Carl C.**, Sales Engr., Wallace & Tiernan, Inc., 1229 W. Washington Ave., Chicago, Ill. (Jan. '57)

**Gallagher, J. E.**, Mgr., Culligan Soft Water Service Co., Anderson, Ind. (Jan. '57)

**Geeslin, Edward**, Supt., Water & Light Works, Box 351, Brady, Tex. (Jan. '57) *M*

**Geyer, Herbert Bennett**, Foreman, Muskegon, Mich. (Jan. '57) *D*

**Gill, Howard W.**, Mgr., Gill Water Co., Powell, Tenn. (Jan. '57) *MP*

**Glass, Andrew Carper**, San. Engr., Directorate of Installations, T.A.C., Langley Field, Va. (Jan. '57) *RP*

**Goffin, George Robert**, Chief Engr., Humes, Ltd., 114 King St., Melbourne, Victoria, Australia (Jan. '57) *D*

**Gonzalez-Hurtado, Hernando**, Civ. Engr., Tech. Sec., Public Works Dept., Apdo. Nal 509, Cali, Colombia (Jan. '57) *PD*

**Goodland, City of**, Howard E. Underwood, City Supt., Goodland, Kan. (Corp. M. Jan. '57) *MRPD*

**Gorman, Horatio Eugene**, Mgr., Water Dept., Monticello, Ark. (Jan. '57) *MRPD*

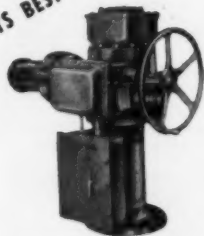
**Green, David P.**, Engr. in Charge, Pollution Control, State Dept., Public Health, State Office Bldg., Cheyenne, Wyo. (Jan. '57) *MRPD*

**Green Island Water Dept.**, Frank A. Wilson, Village Clerk, 20 Clinton St., Green Island, N.Y. (Munic. Sv. Sub. Jan. '57) *MD*

(Continued on page 112 P&R)

# VALVE ACTUATION

ENGINEERING AT ITS BEST



Motor Operated  
Stand with Integral  
Control Equipment

Power actuation is available as a complete carefully engineered unit. Actuation may be by electric motor, air motor, or air or fluid cylinder type motivation. The power unit is compact and self contained, with sturdy supports which attach to the top of any Ludlow Valve.

Manual operation is provided for all electric and air motor operated valves. Our engineers will be glad to help you lay out a plan based on the many years of Ludlow experience in power actuation systems of all kinds for all purposes.

"NO POSSIBLE DIFFERENCE IN FIRST COST CAN  
OVERBALANCE THE PERPETUAL ECONOMY OF QUALITY."

19



MOTOR OPERATED VALVE



CYLINDER OPERATED VALVE

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**VALVES & HYDRANTS**

Since 1861 THE LUDLOW VALVE MANUFACTURING CO. Troy, N. Y.

(Continued from page 110 P&amp;R)

**Greenblatt, Arthur Oscar**, Civ. Eng. Asst., Dept. of Water & Power, 207 S. Broadway, Los Angeles, Calif. (Jan. '57) *RPD*

**Greenhill, Joseph**, Tech. Repr., Bennett & Wright, Ltd., 45 Cranfield Rd., Toronto 16, Ont. (Jan. '57)

**Hagg, Harold**, Gen. Mgr., Culligan Soft Water Service, 4165 College Ave., Indianapolis, Ind. (Jan. '57) *MRPD*

**Hall, J. P.**, Water Supt., Box 926, Sinton, Tex. (Jan. '57) *D*

**Hallock, Clair Brantley**, Civ. Engr., Comrs. of Public Works, Charleston, S.C. (Jan. '57) *D*

**Halt, Jennings**, Plant Operator, Utilities Operating Co., 17 E. Acre Dr., Plantation, Fort Lauderdale, Fla. (Jan. '57) *P*

**Halter, Richard A.**, Supt. of Water & Light, Municipal Utilities, Elk River, Minn. (Jan. '57) *PD*

**Ham, George S., Jr.**, Engr., Porter, Barry & Assocs., Box 1708, Baton Rouge, La. (Jan. '57) *PD*

**Handley, Harold W.**, Governor, State House, Indianapolis, Ind. (Jan. '57) *R*

**Hardie, John W.**, Constr. Engr., Greeley & Hansen, 220 S. State St., Chicago 4, Ill. (Jan. '57) *PD*

**Hardin, J. B.**; see City of Neodesha (Kan.)

**Everett, James Lewis**, Staff Mgr., Direct Sales, Johns-Manville Sales Corp., Box 255, Houston 1, Tex. (Jan. '57) *D*

**Harris, Melvin Leon**, Civ. Engr., Hudgins-Thompson-Ball & Assocs., 1411 Classen Blvd., Oklahoma City, Okla. (Jan. '57) *RPD*

**Hart, William E., Jr.**, Service Engr., The Flox Co., Inc., 1409 Willow St., Minneapolis, Minn. (Jan. '57) *MP*

**Hatch, Charles C.**, Supt., Mech. & Electrical Maintenance, E. Bay Munic. Utility Dist., 2127 Adeline St., Oakland 7, Calif. (Apr. '57)

**Hayes, William S.**, Engr., Board of Fire Underwriters of the Pacific, 208 Eklunel Bldg., Great Falls, Mont. (Jan. '57) *MR*

**Helberg, Harold J.**, Repr., Hershey Mfg., 50 Church St., New York 7, N.Y. (Jan. '57) *D*

**Henderson, Charles William**, Supt., Water Dept., Hope, Ind. (Jan. '57) *PD*

**Hewitt, Claude Wilbur**, Assoc. Hydraulic Engr., State Dept. of Water Resources, 1100 S. Grand, Los Angeles, Calif. (Jan. '57) *RP*

**Hite, George M.**, Partner, Greeley & Hansen, 220 S. State St., Chicago 4, Ill. (Jan. '57) *PD*

**Hixson, John E.**, Supt. of Utilities, Anthony, Kan. (Jan. '57) *MRD*

**Howe, Martin William**, Dist. Mgr., Wallace & Tiernan, 301-395 Main St., Winnipeg, Man. (Jan. '57)

**Hoyt, Charles H.**, Supt. of Utilities, Cimarron, Kan. (Jan. '57) *MRD*

**Huggins, Cecil**, Chemist, Water Works Plant, Columbia, S.C. (Jan. '57) *MP*

**Jerman, Daniel L.**, Sales Agent, Adams Pipe Repair Clamps, 784 Salem St., Teaneck, N.J. (Jan. '57)

**Jeske, Richard J.**, Engr., Guy Villa & Sons, Inc., 1320 Raritan Rd., Clark, N.J. (Jan. '57) *RPD*

**Jester, William J.**, Sales Mgr., The Bond-o Co., 760 Fairview Ave., Fairview, N.J. (Jan. '57) *D*

**Johnson, L. L. Johnny**, Asst. Regional Mgr., Byron Jackson Pumps, Inc., 407 S. Dearborn, Chicago 5, Ill. (Jan. '57)

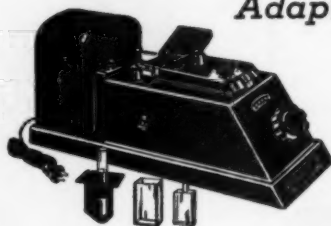
**Jones, William Farbridge**, Chief Civ. Engr., Skidmore, Owings & Merrill, 1 Montgomery St., San Francisco, Calif. (Jan. '57) *RD*

**Katherman, H. P.**; see Sparton Control Systems

(Continued on page 114 P&amp;R)

# KLETT SUMMERSON ELECTRIC PHOTOMETER

*Adaptable for Use in Water  
Analysis*



Can be used for any determination in which color or turbidity can be developed in proportion to substance to be determined

**KLETT MANUFACTURING CO.**  
179 EAST 87th STREET • NEW YORK, N. Y.



## FLOW COEFFICIENT=155

The ebony-like finish on the inside surface of the steel water pipe shown above is a typical spun lining of Bitumastic 70-B AWWA Enamel. This type of lining has been tested and proved to have the highest flow coefficient available today.

That's one reason why steel pipe, lined with Bitumastic 70-B AWWA Enamel is such a good investment for

water lines. Delivery stays high, too, year after year, since this enamel provides the best protection against tuberculation and incrustation known today.

Investigate steel water pipe—lined and coated with Bitumastic 70-B AWWA Enamel—for your next water-supply project.

Koppers Company, Inc., Tar Products Division, Pittsburgh 19, Pa.



ONLY KOPPERS MAKES

**BITUMASTIC**  
REG. U. S. PAT. OFF.  
**70-B ENAMEL**

(Continued from page 112 P&amp;R)

- Kazienko, Henry J.**, Development Engr., Johns-Manville Research Center, Manville, N.J. (Jan. '57) *D*
- Keebler, George W.**, Vice-Pres., Keebler & Matthews Ranches, Inc., 118 N. Brown Ave., Scottsdale, Ariz. (Jan. '57) *MR*
- Keith, George W., Jr.**, Partner, The Chester Engrs., 601 Suisman St., Pittsburgh 12, Pa. (Jan. '57) *MRPD*
- Kipp, Hapgood**, Dist. Mgr., Simplex Valve & Meter Co., E. Orange St., Lancaster, Pa. (Jan. '57) *P*
- Kisiel, Chester C.**, Civ. Eng. Dept., Univ. of Pittsburgh, 4720 McKee Dr., Pittsburgh 36, Pa. (Jan. '57)
- Kobblins, Carl Theodore, Jr.**, Partner, John C. Norton & Assocs., Masonic Bldg., Traverse City, Mich. (Jan. '57) *MRPD*
- Kuhman, Harold E.**, Chief Engr., State Inspection Bureau, Box 559, Oklahoma City 1, Okla. (Jan. '57) *MRD*
- LaFrentz, LeRoy J.**, Owner, Descanso Park Water Co., 11301 W. Pico Blvd., Los Angeles 64, Calif. (Jan. '57) *MD*
- Lemon, Thomas L.**, Mayor, City Hall, Bloomington, Ind. (Jan. '57) *MR*
- Lewis, Harley A.**, Supt., Water & Sewer Dept., Mulberry, Ark. (Jan. '57) *MPD*
- Life, Neville Woodhouse**, Munic. Engr., Municipality of Saanich, Royal Park P.O., Vancouver Island, B.C. (Jan. '57) *MD*
- Lumbert, Bernard C.**, Chemist, Water Dept., 555 Lincoln, Evanston, Ill. (Jan. '57) *P*
- Lunceford, Lyle Douglas**, Asst. Water & Sewer Supt., City Hall, Groves, Tex. (Jan. '57) *PD*
- Mahlert, Karl**; see Thyssensche (Germany) Gas & Waterworks
- Mangun, Kermit A.**, Asst. Chemist, Board of Public Utilities, Quindaro Station, Kansas City, Kan. (Jan. '57) *P*
- Manitou Springs Water Dept.**, J. G. Meury, Supervisor of Public Works, City Hall, 606 Manitou Ave., Manitou Springs, Colo. (Munic. Sv. Sub. Jan. '57) *MPD*
- Mantle, Robert**, Shop Supt., Vernon Water Dept., 412 Griswold Ave., Glendale, Calif. (Oct. '54)
- Martin, P. T.**, Utility Supt., City Hall, Brownwood, Tex. (Jan. '57) *D*
- McBride, Frank Harry**, Sales Engr., B-I-F Industries, Inc., 406 W. 34th St., Kansas City, Mo. (Jan. '57) *P*
- McMains, Norman L., Jr.**, Owner, Culligan Soft Water Service, 723 N. 7th St., Terre Haute, Ind. (Jan. '57) *P*
- McNitt, Willard C.**, Gen. Mgr. of Sales, Clayton Mark & Co., 1900 Dempster St., Evanston, Ill. (Jan. '57) *D*
- Meury, J. G.**; see Manitou Springs (Colo.) Water Dept.
- Michaud, Raymond Frederick**, Civ. Engr., Water Dept., Rm. 401, City Hall, Milwaukee, Wis. (Jan. '57) *D*
- Miller, Jesse**, Water Works, 1604 Main St., Elwood, Ind. (Jan. '57)
- Miller, John W.**, Asst. Mgr., New Jersey Water Co., 214 W. Atlantic Ave., Haddon Heights, N.J. (Jan. '57) *M*
- Musgrave, Dennis C.**, Sr. Engr., Pennock Canadian-British, Ltd., 46 Elgin St., Ottawa, Ont. (Jan. '57)
- Nall, Morris E.**, Partner, Morris E. Nall & Assocs., 604 Prospect, Cleveland 15, Ohio (Jan. '57) *PD*
- Nelson, Carl H.**, Distr. Supervisor, Water Dept., N. 2724 Hamilton, Spokane, Wash. (Jan. '57) *MD*
- Neodesha, City of**, J. B. Hardin, City Engr., Neodesha, Kan. (Corp. M. Jan. '57)

(Continued on page 116 P&amp;R)



For Public Water Fluoridation

**Sodium Silicofluoride—98%**

(Powder)

**Sodium Fluoride—98%**

(Powder or Granular)

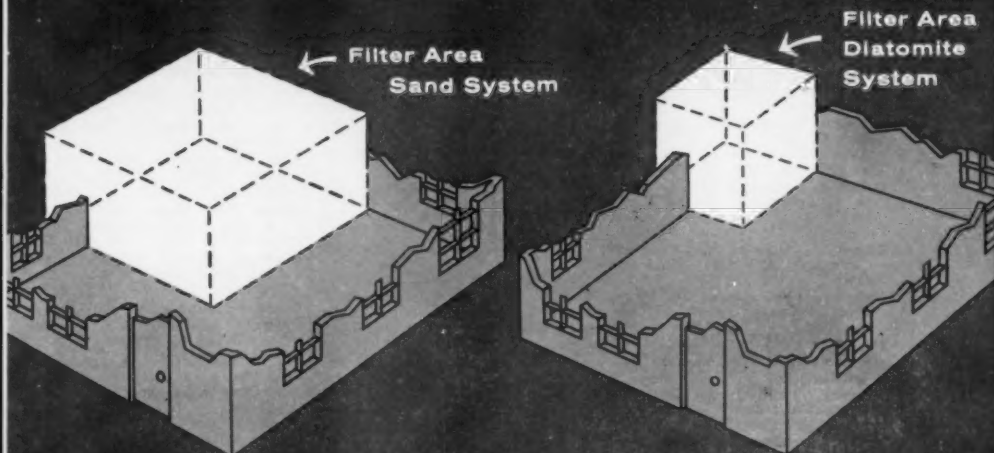
Meet AWWA specifications

White or tinted blue  
Minimum of dust in handling  
Minimum of storage space  
Available in bags and drums

**The AMERICAN AGRICULTURAL CHEMICAL Co.**

50 Church Street, New York 7, N. Y.

**WITH CELITE DIATOMITE FILTRATION  
YOU CAN GET CRYSTAL CLEAR WATER AND...**



*Cut space requirements  
as much as 75%*

A Celite\* diatomite filtration system requires only 1/4 the housing space that a sand filtration system needs to deliver the same water capacity. Because of this, an actual Celite diatomite filter station was installed by Johns-Manville for only 55% of the cost of a comparable sand filter plant.<sup>†</sup>

For those communities that wish to increase their present water capacity but must hold down improvement costs, a Celite diatomite filter can in most cases be added right in the existing sand plant. Capacity can be more than doubled without spending a penny for additional land or construction.

Diatomite systems not only save space, but, under comparable conditions, they also improve water clarity. For with Celite, turbidity is usually lower, and more suspended impurities, including all floc, amoebae and algae, are removed. In fact in some cases, turbidity is so low it can't be measured.

Mined by Johns-Manville at the world's largest and purest commercial diatomite deposit, Celite is carefully processed for purity and uniformity. It is available in a wide range of grades to deliver the best practical balance of clarity and flow rate with any suitable filter. For further information see your nearby Celite engineer or write for free technical reprints and illustrated brochure to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

Celite filter aids are composed of microscopic irregularly shaped particles like these. 90% of a given quantity of Celite is composed of countless channels and voids that trap the finest impurities while permitting the free passage of clear liquid.



\*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products. †See Comparison Studies of Diatomite and Sand Filtration by G. R. Bell, Journal American Water Works Association, September, 1956 or write for free reprint.



**Johns-Manville CELITE Filter Aids**

(Continued from page 114 P&amp;R)

- Newton, Donald**, Partner, Greeley & Hansen, 220 S. State St., Chicago, Ill. (Jan. '57) *RP*
- Ohiendorf, Earl**; see Caseyville (Ill.) Water Co.
- Olympic Welding Co., Inc.**, Willard F. Ault, Pres., 3449—11th Ave., S.W., Seattle 4, Wash. (Assoc. M. Jan. '57)
- Owades, Joseph L.**, Chief Chemist, Schwarz Labs. Inc., 230 Washington St., Mount Vernon, N.Y. (Jan. '57) *MP*
- Papaxian, Albert**, Supt., Saltfleet Township Water Area 1, Winona, Ont. (Jan. '57)
- Pappenhagen, James M.**, Assoc. Prof. of Chem., Kenyon College, Gambier, Ohio (Jan. '57)
- Penna, Edwin**, Sales Repr., Diehl Pump & Supply Co., Robards Lane, Louisville, Ky. (Jan. '57) *R*
- Perrott, Thelo Albert**, Cons. Civ. Engr., 156 University Ave., Palo Alto, Calif. (Jan. '57) *MRD*
- Perry, Bernard T.**, Water Works Accounting, 6208 College Ave., Indianapolis, Ind. (Jan. '57) *M*
- Perrysburg Water Dept.**, Burton Ames, Supt., 205 E. Boundary St., Perrysburg, Ohio (Corp. M. Jan. '57)
- Peters, William H.**, Supt., Dept. of Waterworks, Valparaiso, Ind. (Jan. '57) *M*
- Pickle, Herbert E.**, Director of Public Works, Hollywood, Fla. (Jan. '57) *MRD*
- Puglisi, S. Joseph**, Director of Research & Development, Cuno Eng. Corp., Meriden, Conn. (Jan. '57) *P*
- Purdie, Robert Wright**, Assoc. Engr., Clyde C. Kennedy, 604 Mission St., San Francisco, Calif. (Jan. '57) *RPD*
- Ramos G., Nicolas**; see Cali (Colombia) Public Works Dept.
- Rasinen, Edwin M.**, Personnel Director, Dept. of Water Supply, 735 Randolph, Detroit 26, Mich. (Jan. '57) *M*
- Reinker, Charles A.**, Salesman, Gen. Chem. Div., Allied Chem. & Dye Corp., Rm. 430, The Merchandise Mart, Chicago 54, Ill. (Jan. '57) *P*
- Rose, Hugh Glen, Jr.**, Asst. Engr., State Water Survey, Box 232, Urbana, Ill. (Jan. '57) *RPD*
- Rowley, Albert E.**, Supervisor, Supply Yard, Maintenance & Constr. Div., Dept. of Water Supply, 6129 Radnor Ave., Detroit 24, Mich. (Jan. '57) *D*
- Rutley, Thomas E.**, Supt., Maintenance Div., Bureau of Water Supply, Park Terminal Bldg., Baltimore, Md. (Jan. '57) *MD*
- Saltzman, Curtis D.**, Owner, Sargento Co., Ohio, Ill. (Jan. '57)
- Sampley, John Lowery**, Supt., Water Works Com., Monterey, Tenn. (Jan. '57) *RPD*
- Sanders, Lovie**, Supt., Water & Sewer Dept., Bremen, Ga. (Jan. '57) *MP*
- Sanford, William D.**, Sanitation Foreman, Installations Engr. Office, Stewart Air Force Base, Tenn. (Jan. '57) *MP*
- Schewe, Edward A.**, Chief Mech. Engr., J & G Davenport Co., Grand Rapids, Mich. (Jan. '57) *PD*
- Schillmoller, Charles Marie**, West Coast Tech. Repr., Development & Research Div., International Nickel Co., Inc., 538 Petroleum Bldg., Los Angeles 15, Calif. (Jan. '57) *MPD*
- Schwenk, Henry C.**, Valve Sales Mgr., Henry Pratt Co., 2222 S. Halsted St., Chicago 8, Ill. (Jan. '57) *PD*
- Seaton, Kermit C.**, Supervisor, Water Meter Shop, Public Service Board, El Paso, Tex. (Jan. '57)
- Sellers, Jerry**, Water Plant Supt., Cocoa, Fla. (Jan. '57) *P*
- Sells, James Hunter**, Dist. Mgr., Rockwell Mfg. Co., 525 Market St., San Francisco, Calif. (Jan. '57) *D*
- Shroyer, Edward**, Supt., Treatment Plant, Water Plant, 13th & Richland, Wheeling, W.Va. (Apr. '57)
- Simons, Steve**, Plant Operator, Operator, Public Service Board, Box 7203, El Paso, Tex. (Jan. '57) *RP*
- Smith, Louis J.**, Supervisor, Pan American Petroleum Corp., High Island, Tex. (Jan. '57) *MRPD*
- Snyder, Herschel Simon**, Supt., Water Dept., 202 S. Main St., Liberty, Ind. (Jan. '57)
- Sparton Control Systems**, Div. of Sparton Corp., H. P. Katherman, Gen. Mgr., 2301 E. Michigan Ave., Jackson, Mich. (Assoc. M. Jan. '57)
- Spence, Robert Edwin**, Supt. of Public Works, Improvement Dist., Deep River, Ont. (Jan. '57) *MRD*
- Spencer, O. B.**; see Dixon (Ill.) Water Dept.
- Stewart, Clinton L.**, Engr., DeKalb County Water System, Box 331, Decatur, Ga. (Jan. '57) *MRPD*
- Stolcovy, George Thomas**, Water System Controlman, Public Works Center, Guam, M.I. (Jan. '57) *PD*
- Stone, Wirt J.**, Industrial Chem. Sales, B. Preiser Co., Inc., 1203 Early St., Charleston, W.Va. (Jan. '57)
- Swank, Richard Whitford**, Asst. Civ. Engr., County Court House, Ventura, Calif. (Jan. '57) *MRPD*
- Sylvester, David G.**, 4204 N. Villa, Oklahoma City, Okla. (Apr. '53)
- Templeton, Carson Howard**, Pres., Templeton Eng. Co., 1632 Portage Ave., Winnipeg 12, Man. (Jan. '57) *D*
- Thysensche Gas & Waterworks**, Karl Mahler, Director, Duisburger Strasse 161, Duisburg-Hamborn, Germany (Corp. M. Jan. '57) *MRPD*
- Tolnay, James G.**, Distr. Foreman, Water Dept., 3102 Cedar, Everett, Wash. (Jan. '57) *MRPD*
- Totten, Aubrey James**, Chief Operator, Nitro Water Plant, West Virginia Service, Charleston, W.Va. (Jan. '57) *MP*
- Underwood, Howard E.**; see City of Goodland (Kan.)
- Valentine, Martin J.**, Supt., Munic. Water Dept., 318 Fremont St., Whitewater, Wis. (Apr. '57)
- Van Dintner, Louis**, Foreman, Water & Sewer Dept., 1000 Michigan Ave., Muskegon, Mich. (Jan. '57) *D*
- Vay Ry, Charles Arle**, Supt. of Public Works, 14 Church St., Camden, N.Y. (Jan. '57) *MRPD*
- Vines, Eucl**, Sales Repr., Koppers Co., Inc., 1312 United Artist Bldg., Detroit 26, Mich. (Jan. '57) *D*
- Warden, Thomas Benjamin, Jr.**, Filter Plant Mgr., Williamson Co., Jonestown, Tex. (Jan. '57) *MD*
- Warren, Robert A.**, Asst. Engr., Greeley & Hansen, 220 S. State St., Chicago 4, Ill. (Jan. '57)
- Weatherford, A. E.**, Chemist, Aitchison City Water Works, Inc., Aitchison, Kan. (Jan. '57) *P*
- Webb, Carl L.**, Mgr., Suburban Utility Dist., Rte. 7, Knoxville, Tenn. (Jan. '57) *MRD*
- Webb, Clark D.**, Sales Repr., U. S. Pipe & Foundry Co., 905 Monadnock Bldg., San Francisco 5, Calif. (Jan. '57) *MD*
- Weller, Fred**, Supt., Atlantic Highlands, N.J. (Jan. '57) *RPD*
- Welch, James H.**, Mgr., Water & Sewer Works, Beebe Municipal Water Co., Beebe, Ark. (Jan. '57) *MRPD*
- Welty, Clint**, Sales Repr., Barada & Page, 2041 N. Mosley, Wichita, Kan. (Jan. '57) *MRPD*
- White, William J., Sr.**, Supt., American Valve Mfg. Co., Cossack, N.Y. (Jan. '57)
- Wiehle, William E.**, Utilities Chemist, Goodyear Atomic Corp., Box 628, Portsmouth, Ohio (Jan. '57) *MP*
- Wilson, Anthony Arthur Roy**, Tech. Director, Wilson & Johnstone, Ltd., 3 Broadway, Port of Spain, Trinidad, B.W.I. (Jan. '57) *MRPD*
- Wilson, Frank A.**; see Green Island (N.Y.) Water Dept.
- Wisnabaker, Royce E.**, Cons. Engr., Wisnabaker, Fix & Assocs., 1500 Peoples National Bank Bldg., Tyler, Tex. (Jan. '57) *MRPD*
- Wittesaele, Rene A.**, Water System Maintenance Foreman, Dept. of Water Supply, 735 Randolph St., Detroit, Mich. (Jan. '57) *MD*
- Wyndham, Herbert B., Jr.**, Engr., Malcolm Pirnie Engrs., 25 W. 43rd St., New York 36, N.Y. (Jan. '57) *RP*
- Ye-Shih, Lin**, Assoc. San. Engr., Provincial Health Dept., 2-chung-Zeng St., Mei-nung, Kao-shung, Taiwan (Jan. '57) *RP*
- Young, Harold C.**, 1911 McCall Rd., Austin, Tex. (Apr. '57)
- Young, William F.**, Hydr. Engr., Cornell Univ., Day Hall, Ithaca, N.Y. (Jul. '52)
- Zabban, Walter**, Chester Engrs., 601 Sulmon St., Pittsburgh 12, Pa. (Jan. '57) *MRP*
- Zimmerman, John K.**, Sales Engr., Johns-Manville Sales Corp., Box 2327, Corpus Christi, Tex. (Jan. '57)

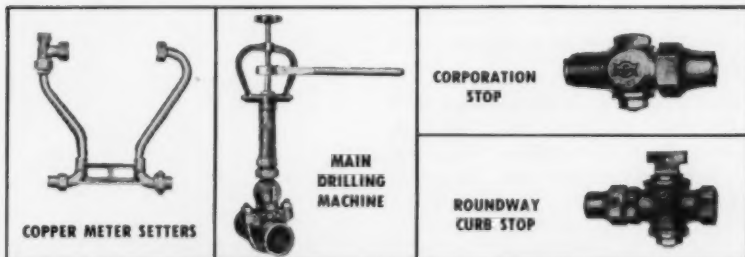
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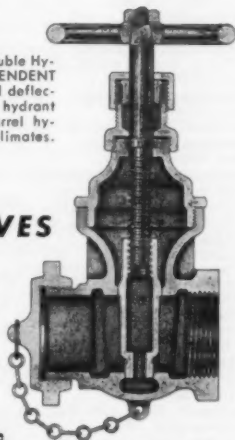
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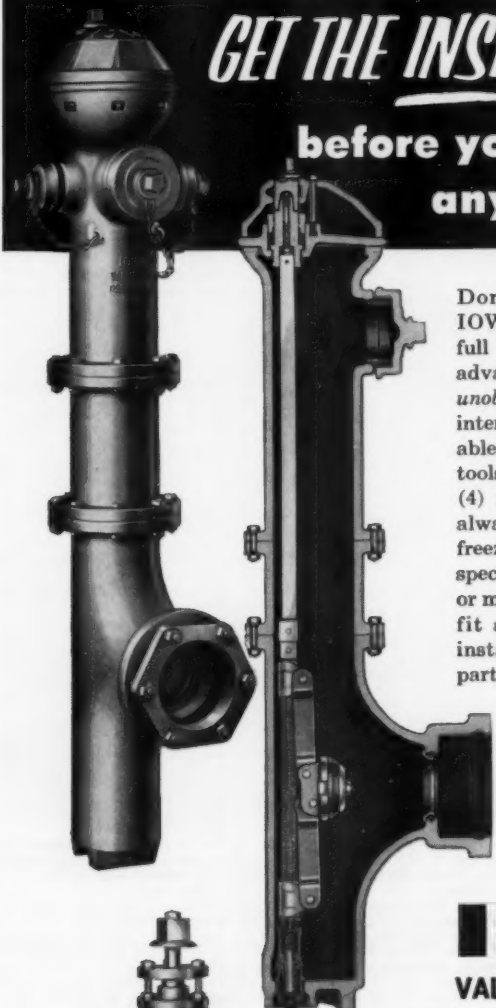
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Inertol Co., Inc.  
Koppers Co., Inc.

**Pipe, Asbestos-Cement:**  
Johns-Manville Corp.  
Keasbey & Mattison Co.

**Pipe, Brass:**  
American Brass Co.

**Pipe, Cast Iron (and Fittings):**  
Alabama Pipe Co.  
American Cast Iron Pipe Co.  
Cast Iron Pipe Research Assn.  
James B. Clow & Sons  
Trinity Valley Iron & Steel Co.  
United States Pipe & Foundry Co.  
R. D. Wood Co.

**Pipe, Cement Lined:**  
American Cast Iron Pipe Co.  
Cast Iron Pipe Research Assn.  
James B. Clow & Sons  
United States Pipe & Foundry Co.  
R. D. Wood Co.

**Pipe, Concrete:**  
American Concrete Pressure Pipe Assn.  
American Pipe & Construction Co.  
Lock Joint Pipe Co.

**Pipe, Copper:**  
American Brass Co.

**Pipe, Steel:**  
Alco Products, Inc.  
Armco Drainage & Metal Products, Inc.  
Bethlehem Steel Co.

**Pipe Cleaning Services:**  
Ace Pipe Cleaning, Inc.  
National Water Main Cleaning Co.

#### **Pipe Cleaning Tools and Equipment:**

Flexible Inc.  
**Pipe Coatings and Linings:**  
American Cast Iron Pipe Co.  
Barrett Div.  
Cast Iron Pipe Research Assn.  
Centriline Corp.  
Inertol Co., Inc.  
Koppers Co., Inc.  
Reilly Tar & Chemical Corp.

**Pipe Cutters:**  
James B. Clow & Sons  
Ellis & Ford Mfg. Co.  
Jos. G. Pollard Co., Inc.  
Reed Mfg. Co.

A. P. Smith Mfg. Co.  
Spring Load Mfg. Corp.

**Pipe Jointing Materials; see Jointing Materials**

**Pipe Locators:**  
W. S. Darley & Co.  
Jos. G. Pollard Co., Inc.

**Pipe Vises:**  
Reed Mfg. Co.  
Spring Load Mfg. Corp.

**Plugs, Removable:**  
James B. Clow & Sons  
Jos. G. Pollard Co., Inc.  
A. P. Smith Mfg. Co.

**Potassium Permanganate:**  
Carus Chemical Co.

**Pressure Regulators:**  
Allis-Chalmers Mfg. Co.  
Foster Eng. Co.  
Golden-Anderson Valve Specialty Co.  
Mueller Co.

Ross Valve Mfg. Co.

**Pumps, Boiler Feed:**  
Allis-Chalmers Mfg. Co.  
DeLaval Steam Turbine Co.  
Worthington Corp.

**Pumps, Centrifugal:**  
Allis-Chalmers Mfg. Co.  
American Well Works  
DeLaval Steam Turbine Co.  
C. H. Wheeler Mfg. Co.  
Worthington Corp.

**Pumps, Chemical Feed:**  
Inflico Inc.  
Proportioners, Inc. (Div., B-I-F Industries)

Wallace & Tiernan Inc.

**Pumps, Deep Well:**  
American Well Works  
Layne & Bowler, Inc.  
Worthington Corp.

**Pumps, Diaphragm:**  
Dorr-Oliver Inc.  
W. S. Rockwell Co.  
Wallace & Tiernan Inc.

**Pumps, Hydrant:**  
W. S. Darley & Co.  
Jos. G. Pollard Co., Inc.

**Pumps, Hydraulic Booster:**  
Ross Valve Mfg. Co.

**Pumps, Sewage:**  
Allis-Chalmers Mfg. Co.  
DeLaval Steam Turbine Co.  
C. H. Wheeler Mfg. Co.  
Worthington Corp.

**Pumps, Sump:**  
DeLaval Steam Turbine Co.  
C. H. Wheeler Mfg. Co.  
Worthington Corp.

**Pumps, Turbine:**  
DeLaval Steam Turbine Co.  
Layne & Bowler, Inc.

**Recorders, Gas Density, CO<sub>2</sub>, NH<sub>3</sub>, SO<sub>2</sub>, etc.:**  
Permutit Co.  
Wallace & Tiernan Inc.

**Recording Instruments:**  
Builders-Providence, Inc. (Div., B-I-F Industries)  
Fischer & Porter Co.  
Inflico Inc.

Minneapolis-Honeywell Regulator Co.

Simplex Valve & Meter Co.  
Wallace & Tiernan Inc.

**Reservoirs, Steel:**  
Bethlehem Steel Co.  
Chicago Bridge & Iron Co.  
R. D. Cole Mfg. Co.  
Graver Tank & Mfg. Co.  
Hammond Iron Works  
Pittsburgh-Des Moines Steel Co.  
Sparling Meter Co.

**Sand Expansion Gages; see Gages**

**Sleeves; see Clamps**

**Sleeves and Valves, Tapping:**  
James B. Clow & Sons  
M & H Valve & Fittings Co.  
Mueller Co.  
Rensselaer Valve Co.  
A. P. Smith Mfg. Co.

**Sludge Blanket Equipment:**  
General Filter Co.  
Graver Water Conditioning Co.  
Permutit Co.

**Sodium Aluminate:**  
Monolith Portland Midwest Co.

**Sodium Chloride:**  
Frontier Chemical Co.  
International Salt Co., Inc.

**Sodium Fluoride**  
American Agricultural Chemical Co.

**Sodium Hexametaphosphate:**  
Calgon, Inc.

**Sodium Hypochlorite:**  
John Wiley Jones Co.  
Wallace & Tiernan Inc.

**Sodium Silicate:**  
Philadelphia Quartz Co.

**Sodium Silicofluoride**  
American Agricultural Chemical Co.

**Softeners:**  
Cochrane Corp.  
Dorr-Oliver Inc.  
General Filter Co.  
Graver Water Conditioning Co.  
Hungerford & Terry, Inc.  
Inflico Inc.  
Permutit Co.  
Roberts Filter Mfg. Co.  
Walker Process Equipment, Inc.

**Softening Chemicals and Compounds:**  
Calgon, Inc.  
Cochrane Corp.  
General Filter Co.  
Inflico Inc.  
International Salt Co., Inc.  
Permutit Co.  
Tennessee Corp.

**Standpipes, Steel:**  
Bethlehem Steel Co.  
Chicago Bridge & Iron Co.  
R. D. Cole Mfg. Co.  
Graver Tank & Mfg. Co.  
Hammond Iron Works  
Pittsburgh-Des Moines Steel Co.

**Steel Plate Construction:**  
Alco Products, Inc.  
Bethlehem Steel Co.  
Chicago Bridge & Iron Co.  
R. D. Cole Mfg. Co.  
Graver Tank & Mfg. Co.  
Hammond Iron Works  
Pittsburgh-Des Moines Steel Co.

**Stops, Curb and Corporation:**  
Hays Mfg. Co.  
Mueller Co.

**Storage Tanks; see Tanks**



### *Waterspheroid at Ocala, Florida*

This 500,000-gallon Waterspheroid stores 500,000 gallons of water and serves the Northeast section of the City of Ocala. The tank, used for general service and fire protection, has a diameter of 55 feet, 6 inches. The tank is 132 feet, 6 inches to the bottom capacity line.

Horton Ellipsoidal bottom elevated tanks, standpipes, reservoirs, radial-cone tanks and Waterspheres are also available to meet your water storage requirements. Write our nearest office for an estimate or information.

## **CHICAGO BRIDGE & IRON COMPANY**

Plants in Birmingham, Chicago, Salt Lake City and Greenville, Pa.

BIRMINGHAM  
PHILADELPHIA  
SAN FRANCISCO  
CHICAGO

NEW YORK  
HOUSTON  
TULSA  
DETROIT

ATLANTA  
BOSTON  
SEATTLE  
CLEVELAND

SALT LAKE CITY  
SOUTH PASADENA  
PITTSBURGH  
NEW ORLEANS

In Canada—HORTON STEEL WORKS, LIMITED, FORT ERIE, ONT.

**Strainers, Suction:**

James B. Clow & Sons  
M. Greenberg's Sons  
Johnson, Edward E., Inc.  
R. D. Wood Co.

**Surface Wash Equipment:**

Cochrane Corp.  
Permutit Co.

**Swimming Pool Sterilization:**

Builders-Providence, Inc. (Div.,  
B-I-F Industries)  
Fischer & Porter Co.  
Omega Machine Co. (Div., B-I-F  
Industries)  
Proportioners, Inc. (Div., B-I-F  
Industries)  
Wallace & Tiernan Inc.

**Tanks, Steel:**

Alco Products, Inc.  
Bethlehem Steel Co.  
Chicago Bridge & Iron Co.  
R. D. Cole Mfg. Co.  
Graver Tank & Mfg. Co.  
Hammond Iron Works  
Pittsburgh-Des Moines Steel Co.

**Tapping-Drilling Machines:**

Hays Mfg. Co.  
Mueller Co.  
A. P. Smith Mfg. Co.

**Tapping Machines, Corp.:**

Hays Mfg. Co.  
Mueller Co.

**Taste and Odor Removal:**

Builders-Providence, Inc. (Div.,  
B-I-F Industries)  
Cochrane Corp.  
General Filter Co.  
Graver Water Conditioning Co.  
Industrial Chemical Sales Div.  
Inflico Inc.  
Permutit Co.  
Proportioners, Inc. (Div., B-I-F  
Industries)  
Wallace & Tiernan Inc.

**Tenoning Tools:**

Spring Load Mfg. Corp.

**Turbidimetric Apparatus (For  
Turbidity and Sulfate De-  
terminations):**

Wallace & Tiernan Inc.

**Turbines, Steam:**

Allis-Chalmers Mfg. Co.  
DeLaval Steam Turbine Co.

**Turbines, Water:**

Allis-Chalmers Mfg. Co.  
DeLaval Steam Turbine Co.

**Valve Boxes:**

James B. Clow & Sons  
Ford Meter Box Co.  
M & H Valve & Fittings Co.  
Mueller Co.  
Rensselaer Valve Co.  
A. P. Smith Mfg. Co.  
Trinity Valley Iron & Steel Co.  
R. D. Wood Co.

**Valve-Inserting Machines:**

Mueller Co.  
A. P. Smith Mfg. Co.

**Valves, Altitude:**

Golden-Anderson Valve Specialty Co.  
W. S. Rockwell Co.  
Ross Valve Mfg. Co., Inc.  
S. Morgan Smith Co.

**Valves, Butterfly, Check, Flap,**

**Foot, Hose, Mud and Plug:**  
Builders-Providence, Inc. (Div.,  
B-I-F Industries)

Chapman Valve Mfg. Co.  
James B. Clow & Sons  
DeZurik Corp.  
M. Greenberg's Sons  
Kennedy Valve Mfg. Co.  
M & H Valve & Fittings Co.  
Mueller Co.  
Henry Pratt Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
S. Morgan Smith Co.  
R. D. Wood Co.

**Valves, Detector Check:**

Hersey Mfg. Co.

**Valves, Electrically Operated:**

Builders-Providence, Inc. (Div.,  
B-I-F Industries)  
Chapman Valve Mfg. Co.  
James B. Clow & Sons  
Crane Co.  
Darling Valve & Mfg. Co.  
DeZurik Corp.  
Golden-Anderson Valve Specialty Co.  
Kennedy Valve Mfg. Co.  
M & H Valve & Fittings Co.  
Mueller Co.  
Henry Pratt Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
A. P. Smith Mfg. Co.  
S. Morgan Smith Co.

**Valves, Float:**

James B. Clow & Sons  
Golden-Anderson Valve Specialty Co.  
Henry Pratt Co.  
W. S. Rockwell Co.  
Ross Valve Mfg. Co., Inc.

**Valves, Gate:**

Chapman Valve Mfg. Co.  
James B. Clow & Sons  
Crane Co.  
Darling Valve & Mfg. Co.  
DeZurik Corp.  
Dresser Mfg. Div.  
Kennedy Valve Mfg. Co.  
Ludlow Valve Mfg. Co., Inc.  
M & H Valve & Fittings Co.  
Mueller Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
A. P. Smith Mfg. Co.  
R. D. Wood Co.

**Valves, Hydraulically Oper-  
ated:**

Builders-Providence, Inc. (Div.,  
B-I-F Industries)  
Chapman Valve Mfg. Co.  
James B. Clow & Sons  
Crane Co.  
Darling Valve & Mfg. Co.  
DeZurik Corp.  
Golden-Anderson Valve Specialty Co.  
Kennedy Valve Mfg. Co.  
F. B. Leopold Co.  
M & H Valve & Fittings Co.  
Mueller Co.  
Henry Pratt Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
A. P. Smith Mfg. Co.  
S. Morgan Smith Co.  
R. D. Wood Co.

**Valves, Large Diameter:**

Chapman Valve Mfg. Co.

**James B. Clow & Sons**

Crane Co.  
Darling Valve & Mfg. Co.  
Golden-Anderson Valve Specialty Co.  
Kennedy Valve Mfg. Co.  
Ludlow Valve Mfg. Co., Inc.  
M & H Valve & Fittings Co.  
Mueller Co.  
Henry Pratt Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
A. P. Smith Mfg. Co.  
S. Morgan Smith Co.  
R. D. Wood Co.

**Valves, Regulating:**

DeZurik Corp.  
Foster Eng. Co.  
Golden-Anderson Valve Specialty Co.  
Minneapolis-Honeywell  
Regulator Co.  
Mueller Co.  
Henry Pratt Co.  
W. S. Rockwell Co.  
Ross Valve Mfg. Co.  
S. Morgan Smith Co.

**Valves, Swing Check:**

Chapman Valve Mfg. Co.  
James B. Clow & Sons  
Crane Co.  
Darling Valve & Mfg. Co.  
Golden-Anderson Valve Specialty Co.  
M. Greenberg's Sons  
M & H Valve & Fittings Co.  
Mueller Co.  
Rensselaer Valve Co.  
W. S. Rockwell Co.  
A. P. Smith Mfg. Co.  
R. D. Wood Co.

**Venturi Tubes:**

Builders-Providence, Inc. (Div.,  
B-I-F Industries)  
Inflico Inc.

Simplex Valve & Meter Co.

**Waterproofing:**

Barrett Div.  
Inertol Co., Inc.  
Koppers Co., Inc.

**Water Softening Plants; see  
Softeners****Water Supply Contractors:**

Layne & Bowler, Inc.

**Water Testing Apparatus:**

Wallace & Tiernan Inc.

**Water Treatment Plants:**

American Well Works  
Chain Belt Co.  
Chicago Bridge & Iron Co.  
Cochrane Corp.  
Dorr-Oliver Inc.  
Etablissements Degremont  
Fischer & Porter Co.  
General Filter Co.  
Graver Water Conditioning Co.  
Hammond Iron Works  
Hungerford & Terry, Inc.  
Inflico Inc.  
Permutit Co.  
Pittsburgh-Des Moines Steel Co.  
Roberts Filter Mfg. Co.  
Walker Process Equipment, Inc.  
Wallace & Tiernan Inc.

**Well Drilling Contractors:**

Layne & Bowler, Inc.

**Wrenches, Ratchet:**

Dresser Mfg. Div.

Zeolite; see Ion Exchange  
Materials

A complete Buyers' Guide to all water works products and services offered by AWWA Associate Members appears in the 1955 AWWA Directory.

## Impact Insurance Against



**1—LOSS OF FIRE PROTECTION.**

**2—EXCAVATION AND PAVEMENT REPLACEMENT.**

**3—COSTLY REPAIRS INVOLVING MAJOR HYDRANT COMPONENTS.**

**4—FLOODING.**

The Smith Protectop Hydrant is designed to permit rapid return to service at minimum cost when a Hydrant is damaged as a result of a traffic accident.

The Protectop Hydrant Standpipe and Valve Stem are equipped with Special Couplings located just above the ground. The Couplings withstand operating pressures and ordinary impact with an ample factor of safety. Under excessive impact occasioned by traffic accidents the Couplings fracture at the design points thus minimizing the damage and permitting speedy return to service at low cost.

All Smith Hydrants are equipped with Compression Type Valves which definitely eliminate flooding since the line pressure holds the Valve against its seat in the closed position.

Write for details.

38



# THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

## Rockwell Dual Unit Compound Meter Assemblies



### **EASIEST To Handle, Install, Service**

Big, bulky 8 in. compound meters are always a trial to install, even more of a problem to service. Now, with Rockwell—two meter single register compound manifolds you can save time and money. The complete assembly weighs approximately 100 lbs. less than a single big meter. Two men can handle it with ease. Maintenance of this Rockwell unit is a cinch. Either meter can be used to record off-peak loads while a new or repaired meter is being installed. And remember, Rockwell Dual Unit meter assemblies are razor sharp

in the measurement department. They record *all the flows* with far greater accuracy than a single 8" compound. And they cost less. Write for latest bulletin.

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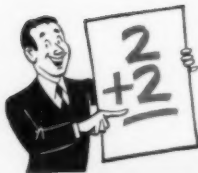
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### **ROCKWELL WATER METERS**

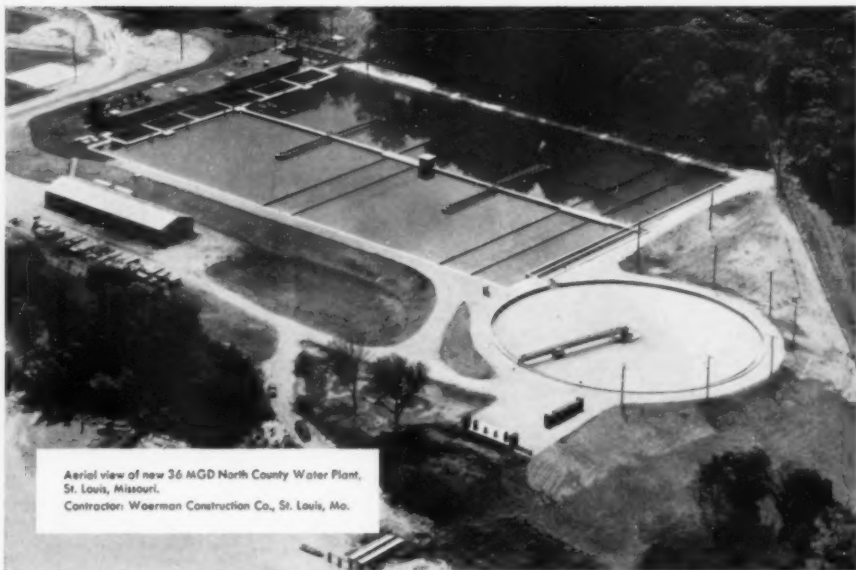
*A Size and Type For Every Kind of Service*





*The solution to this problem is always the same . . . but*  
**Water Treatment Problems are different**

No two water treatment problems are exactly alike. The right solution to each can only be arrived at after a careful study of the local conditions. Variables such as raw water composition, rate of flow and results required automatically rule out the cure-all approach. The installation shown below is a good example of how equipment should be selected to fit the job . . . and not vice versa.



Aerial view of new 36 MGD North County Water Plant,  
 St. Louis, Missouri.  
 Contractor: Waerman Construction Co., St. Louis, Mo.

## St. Louis County, Missouri

*New 36 MGD North County Plant Designed and Constructed in Less than 11 Months*

One of the three water purification plants operated by the St. Louis County Water Company, the North County Plant began operation in 1955. Designed for a capacity of 36 MGD, this plant was designed and constructed in less than eleven months. The plant is located on the South bank of the Missouri River because of favorable river channel conditions for intake operation and because it would be possible to protect the plant against maximum river floods.

In the flowsheet at the North County Plant a 130'

dia. Dorr Heavy-Duty Torq Clarifier serves as the pre-sedimentation basin. This basin, which holds 4,300,000 gallons, provides a detention time of approximately 2½ hours. Four Dorrco Squarex Clarifiers, each 145' sq., comprise the primary and secondary settling zones.

If you would like more information on the complete line of Dorr-Oliver Water Treatment Equipment, write for Bulletin No. 9141, Dorr-Oliver Incorporated, Stamford, Connecticut.

*Every day over 8½ billion gallons of water are treated by Dorr-Oliver equipment.*  
Squarex Trademark Reg. U. S. Pat. Off.



**DORR-OLIVER**  
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 WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT  
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# LEADITE

## Jointed for . . . Permanence with LEADITE

Generally speaking, most Water Mains are buried beneath the Earth's surface, to be forgotten,—they are to a large extent, laid for permanency. Not only must the pipe itself be dependable and long lived,—but the joints also must be tight, flexible, and long lived,—else leaky joints are apt to cause the great expense of digging up well-paved streets, beautiful parks and estates, etc.

Thus the "jointing material" used for bell and spigot Water Mains **MUST BE GOOD**,—**MUST BE DEPENDABLE**,—and that is just why so many Engineers, Water Works Men and Contractors aim to **PLAY ABSOLUTELY SAFE**, by specifying and using **LEADITE**.

Time has proven that **LEADITE** not only makes a tight durable joint,—but that it improves with age.

*The pioneer self-caulking material for c. i. pipe.  
Tested and used for over 40 years.  
Saves at least 75%*



**THE LEADITE COMPANY**  
Girard Trust Co. Bldg. Philadelphia, Pa.

## No Caulking

